

# Original sin redux: a model-based evaluation\*

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## Abstract

Many emerging markets (EMs) have graduated from “original sin” and are able to borrow from abroad in their local currency. Using a two-country model, this paper shows that the shift from foreign currency to local currency external borrowing reduces the vulnerability of EMs to foreign financial shocks to some extent, but does not eliminate it. Instead, it transforms the original sin into a "redux" (Carstens and Shin (2019)). Even under local currency borrowing from foreign lenders, a monetary tightening abroad is propagated to EM financial conditions through a tightening of foreign lenders’ financial constraints. Moreover, local currency borrowing does not eliminate currency mismatches, but shifts them from the balance sheets of EM borrowers to the balance sheets of financially constrained global lenders, so that amplifying financial effects of exchange rate fluctuations persist. We provide empirical evidence in line with this prediction of the model using data on currency composition of external debt of emerging and advanced economies. Our model-based analysis further suggests that foreign exchange intervention and capital flow management measures can mitigate the adverse effects of capital flow swings in the short run and that a larger domestic investor base could reduce the vulnerability of EMs in the longer run.

JEL classification: E3, E5, F3, F4, F6, G1

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# 1 Introduction

Emerging markets (EMs) have in the past often been unable to borrow abroad in their domestic currency, a phenomenon referred to as “original sin” (Eichengreen and Hausmann (1999), Eichengreen et al. (2002) and Eichengreen et al. (2005)). Since EM borrower assets are typically denominated in local currency, foreign currency debt often induces currency mismatches on borrower balance sheets which make an economy vulnerable to exchange rate depreciation raising the value of external liabilities relative to assets. Such currency mismatches have played a key role in many of the EM twin exchange rate and financial crises of the 1990s, such as the 1997 Asian financial crisis, when sudden and sharp exchange rate depreciation fueled financial and economic meltdowns.

In the wake of these crises, many EMs have developed and deepened their local currency bond markets and attracted foreign investors by bringing down inflation and strengthening creditor rights, enabling them to borrow from abroad in their own currency. However, overcoming original sin has not led to “redemption”. EMs have remained vulnerable to capital flow and exchange rate swings because foreign investors often play an important role in their local currency bond markets (BIS (2019), Hofmann et al. (2020a)). This vulnerability was also exposed during the recent Covid-19 induced selloff in EM local currency bond markets, where record bond fund outflows and sharp exchange rate depreciation went hand in hand with steep increases in local currency bond yields (Hofmann et al. (2020b), Hördahl and Shim (2020)).

Carstens and Shin (2019) refer to this enduring vulnerability of EMs to external shocks as “original sin redux”. They point out that EM local currency borrowing from foreign lenders has not eliminated currency mismatches, but has shifted them from domestic borrowers’ to foreign lenders’ balance sheets. To the extent that these foreign lenders are financially constrained or remain risk averse with respect to their investments in EMs, the original sin is not eliminated, but instead reappears in the form of a redux. Carstens and Shin (2019) further argue that the causes of EMs’ vulnerability go beyond the original sin, as they are rooted in the shallowness of their financial markets and the lack of a sizable domestic investor base. This makes EMs dependent on external borrowing (irrespective of the currency of denomination) in the first place, and makes it difficult for international lenders to hedge currency risks, in turn increasing their risk aversion towards EMs in times of market stress.

This paper provides a model-based evaluation of the original sin redux hypothesis. To this end, we set up, following Banerjee et al. (2016), a two-country New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model featuring an EM (the home economy) and an advanced economy (AE, the foreign economy). This is an important deviation from

the literature which has typically studied the implications of capital flows in a small open economy setting.<sup>1</sup> We show that a full dynamic general equilibrium characterization of the balance sheet constraints of AE lenders, which is based on [Gertler and Karadi \(2011\)](#), and their implications for EM borrowers is critical to analyze the original sin redux hypothesis.

In the baseline model, EM firms borrow from domestic financial intermediaries to finance investment. The financial intermediaries could be both banks or non-bank financial intermediaries like investment funds. EM intermediaries in turn obtain their funding from AE financial intermediaries and from domestic households. Both EM and AE financial intermediaries face a funding constraint that is governed by their net worth.<sup>2</sup>

The presence of financial frictions on both lender (AE) and borrower (EM) balance sheets allows us to study the impact of a foreign shock (as well as domestic shocks) on EMs under both foreign currency borrowing (original sin or OS) and local currency borrowing from foreign sources (original sin redux or OSR). Intermediary balance sheet constraints and financial feedback effects of the exchange rate play an important role under both scenarios. When the EM currency depreciates in the wake of a foreign financial tightening, the value of loans, which are in local currency, declines relative to the value of the liabilities, which are in foreign currency. This leads to a drop in net worth for the EM bank in the case of the original sin, and for the global bank in the case of the original sin redux. In either case, there is a tightening in lending conditions that affects the real economy in EM. The effect is muted in the case of the original sin redux because financial constraints of EM banks are tighter than those of global lenders. At the same time, AE lenders' balance sheet constraints are a key channel of transmission of AE financial shocks to EMs independent from any exchange rate amplification effects. The tightening of balance sheet constraints of AE lenders through a tightening of AE financial conditions directly leads to a cut back in credit supply to EMs which is then further amplified by financial feedback effects of exchange rate depreciation.

Based on this framework, we obtain the following main findings. First, in the absence of financial constraints of AE lenders, local currency borrowing eliminates much of the vulnerability to external shocks in the EM. In this sense, local currency borrowing does lead to a “redemption” of original sin, as would be concluded from small open economy models that do not take account of financial constraints of global lenders. The trade channel dominates

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<sup>1</sup>See for instance [Adrian et al. \(2020\)](#), [Basu et al. \(2020\)](#), [Engel and Park \(2018\)](#) and [Ottonello and Perez \(2019\)](#).

<sup>2</sup>We focus on the currency mismatch problem in the financial sector, which is the focus in many recent capital flow studies, such as [Bruno and Shin \(2015\)](#). In the model, production firms and banks can be viewed as one single entity, so the model features currency mismatch in the private sector in a broad sense. As currency denomination is the key for our analysis, we abstract from sovereign debt in our baseline model to avoid any monetary commitment issue (inflating away local currency debt). That said, section 6 provides a simple extension of the model with sovereign debt.

in this case, so that exchange rate depreciation triggers output expansion in EMs in the wake of a foreign monetary tightening. On the other hand, with OS, the financial channel of the exchange rate operating via the borrower balance sheets dominates and output falls.

Second, when financial frictions are present in both AE and EM financial intermediaries, an AE monetary tightening triggers a fall in EM output even when the EM borrows in local currency, i.e. in the OSR scenario. This is because the shock which originates in the AE leads to a decline in the net worth of AE lenders, limiting their ability to lend. EM currency depreciation triggers further losses in the AE financial intermediary balance sheets and limits their lending capacity even more. This mirrors the exchange rate effect on EM balance sheets under the OS scenario, and suggests that local currency borrowing does not eliminate EMs' vulnerability to foreign financial shocks as it just shifts the currency mismatch to the balance sheets of AE lenders.

Third, defensive policies such as FX intervention and capital flow management measures can mitigate the adverse consequences of foreign financial shocks for EMs both under OS and under OSR. In particular, we show that sterilized FX intervention can help mitigate the negative impact of external financial shocks via a "debt limit relaxation" channel. Specifically, a sterilized intervention that sells FX reserves and transfers the proceeds to domestic financial institutions relaxes their leverage constraint and increases the available funds for lending, thereby mitigating the impact of the shock. On the other hand, FX intervention targeted at agents that are not financially constrained (such as households in our model) does not provide any benefits. As such, our results show that it is not FX intervention per se, but rather liquidity-providing central bank balance sheet policy more generally that matters.

Fourth, in the longer run, financial development and deepening is key to reduce EMs' vulnerability to capital flow fluctuations. We find that a larger domestic investor base reduces the impact on EM financial and economic conditions of external shocks under both OS and OSR. This happens because greater availability of domestic funding sources reduces the dependence on borrowing from abroad.

Finally, the currency domination of foreign borrowing also affects the strength of domestic monetary transmission. Specifically, under OSR the effects of a change in the domestic EM stance of monetary policy has a greater financial and economic impact. This happens because expected future exchange rate changes after the initial exchange rate adjustment induce foreign lenders to change lending conditions in a way that reinforces the effects of domestic monetary policy. Domestic monetary transmission is further strengthened if the domestic investor base is larger because a larger share of funding sources is then susceptible to changes in domestic rather than foreign monetary policy.

Overall, the results highlight that while EMs can partially reduce their vulnerability

to external financial shocks by overcoming original sin and borrowing in their domestic currency, they cannot fully eliminate it if AE lenders are financially constrained. Activation of additional policy tools, such as FX intervention and capital flow measures, can help address the enduring challenges faced by EMs from fluctuations in global financial conditions. These results are consistent with the observation that EMs have remained vulnerable to capital flow swings also after overcoming original sin and that they responded to this challenge through a pragmatic design of their macro-financial stability frameworks, commonly combining inflation targeting with FX intervention and macroprudential tools (BIS (2019)). In the longer run, reducing vulnerability to external shocks has to be achieved by addressing its root cause, which is the shallowness of EM financial markets reflected in particular in a thin domestic investor base (Carstens and Shin (2019)).

The remainder of this paper is structured as follows. This section ends with a brief overview of the related literature. Section 2 presents stylized facts that motivate this paper, and conducts an empirical exercise to uncover the role of currency of denomination of external debt in determining the vulnerability of EMs to foreign shocks. Section 3 presents the model. Section 4 discusses the main results and policy implications. Section 6 presents an extension of the model that allows for sovereign debt. Section 7 concludes.

## Literature Review

This paper relates to the extensive literature on original sin, pioneered by Eichengreen et al. (2002) and Eichengreen et al. (2005). This literature has emphasized the inability of EMs to issue external debt in domestic currency, giving rise to balance sheet vulnerabilities from currency mismatches. As a result, in EMs, exchange rates may not play the stabilizing role as in the standard Mundell-Flemming framework through the traditional trade channel. This has provided a rationale for many EMs' preference for managed exchange rate regimes, a phenomena that Calvo and Reinhart (2002) term the “fear of floating”, and has motivated the first generation of models exploring the implications of debt dollarization for spillovers and monetary policy in EMs.<sup>3</sup>

More recently, the literature has moved towards understanding the implications of currency mismatches in the presence of financial amplifications mechanisms, giving rise to the now extensive literature on the financial channels of capital flow and exchange rate swings. These models combine the currency mismatch features of the previous generation of models with financial amplification mechanisms such as those in Bernanke et al. (1999) and Gertler et al. (2010). Prominent recent examples of this strand of the literature include Akinci and Queralto

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<sup>3</sup>see for instance Aghion et al. (2001), Céspedes et al. (2004) and Cook (2004)

(2018), [Aoki et al. \(2016\)](#) , [Gourinchas \(2018\)](#) and [Mendoza and Rojas \(2019\)](#). [Akinci and Queralto \(2018\)](#) consider a two country model with dollar invoicing and dollar debt and show that these features imply large spillovers from US monetary policy to EMs. [Aoki et al. \(2016\)](#) consider a model with both domestic and external (foreign currency) debt, and show that foreign shocks, in particular interest rate shocks, can lead to large spillovers, with financial channels dominating the trade channel. Similar to our paper, they show that additional policy tools (macroprudential policies in their case) can be a valuable addition to the toolkit of policymakers. Recent papers developed under the IMF’s integrated policy framework (IPF) initiative also highlight the relevance of additional policy tools, including FX intervention, in the presence of capital inflows and the financial channel of the exchange rate (see for instance [Basu et al. \(2020\)](#) and [Adrian et al. \(2020\)](#)). These papers focus on financial frictions on the EM borrowers’ (and not lenders’) balance sheets. We contribute to the literature by analyzing the effect of financial friction on both EM borrowers and AE lenders, therefore allowing for a distinction between original sin and original sin redux.

Inspired by the global financial cycle hypothesis of [Rey \(2013\)](#), several recent papers have shifted the focus from borrowers’ to lenders’ balance sheet frictions. Prominent examples include [Morelli et al. \(2021\)](#), [Bruno and Shin \(2014\)](#), and [Banerjee et al. \(2016\)](#). Among these, our framework is closest to [Banerjee et al. \(2016\)](#), [Devereux et al. \(2020\)](#) and [Chen et al. \(2021\)](#), which in turn build on the framework of banking frictions of [Gertler and Karadi \(2011\)](#). [Banerjee et al. \(2016\)](#) show that international monetary policy coordination does not yield welfare improvements compared to optimal self-oriented monetary policies. [Devereux et al. \(2020\)](#) assess how optimal practical rules for monetary policy trading off domestic inflation volatility with foreign factors and financial imbalances can be characterized in financially integrated economies. [Chen et al. \(2021\)](#) explore, focusing on Asian EMs, the role of the banking sector in transmitting global financial spillovers and evaluate the effectiveness of foreign exchange intervention and other macroeconomic policies in responding to external financing shocks. Our focus is different, namely on the effect of switching from foreign to local currency denominated external borrowing and the associated policy implications.

On the empirical front, the literature on the financial channel of capital flows and the exchange rate has grown significantly in recent years against the backdrop of a surge in capital flows to EMs after the Great Financial Crisis. For instance, [Kearns and Patel \(2016\)](#) show that the financial channel of exchange rates is particularly strong in EMs, and more or less offsets the trade channel. [Banerjee et al. \(2020\)](#) document that exchange rates affect corporate investment primarily via a financial, as opposed to a trade channel. [Bruno and Shin \(2019\)](#) show that even for exporting firms the financial channel of the exchange rate often tends to dominate the trade channel through its impact on trade credit conditions. [Hofmann](#)

et al. (2020a) analyze the impact of exchange rate shocks on EM local currency bond spreads and find that currency appreciation shocks lead to a compression of bond spreads. Bertaut et al. (2020) use a detailed database of US investor flows to emerging markets to show that local currency flows are even more volatile than hard currency flows, driven in large part by mutual fund flows which tend to be more cyclical and carry heavier investments in local currency bonds on average. We provide, based on a DSGE model, conceptual support for this empirical evidence, highlighting the critical role of balance sheet constraints on the lenders' side.

Lastly, our paper also links to the literature evaluating the effectiveness of foreign exchange intervention in the presence of financial frictions (see for instance Cavallino (2019), Chang (2018), Cavallino and Sandri (2020) and Hofmann et al. (2019)). Cavallino and Patel (2019) summarize a recent survey of EM central banks and highlight that FX interventions are increasingly used to counter the financial, as opposed to the trade channel (price stability and competitiveness) of exchange rates. Consistent with this literature, we highlight the role of FX intervention in addressing domestic financial constraints through the sterilization leg of the intervention.

## 2 Motivating facts and evidence

### 2.1 External borrowing and financial structure of EMs

Many EMs have made significant progress towards overcoming original sin over the last two decades and are increasingly borrowing from abroad in their local currency. Figure 1 shows the share of total external debt liabilities for a balanced sample of 14 EMs that is denominated in local currency. The median share has more than doubled since 2000, from under 0.1 to above 0.2 in 2017. The figure also suggests that, according to this measure of original sin, EMs have become very similar to AEs where the median share stood at about 0.25 in recent years.<sup>4</sup>

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<sup>4</sup>The share might however be biased downward due to incomplete coverage of corporate sector external borrowing in local currency. Du and Schreger (2021) document that local currency borrowing in EMs takes place largely through the government sector where the local currency share in external debt amounts to more than 60%, while corporates still rely almost exclusively on FX debt with a local currency external borrowing share of only about 10%. However, local currency borrowing from abroad by corporates might be underestimated because indirect borrowing from abroad through domestic banks is not accounted for. As documented by Avdjiev et al. (2020), corporates can borrow from abroad in three ways: (i) direct bond issuance in international markets, (ii) direct cross-border borrowing from foreign banks, and (iii) indirect borrowing from abroad through domestic banks. The local currency share in the latter component appears to be considerably larger than that in the first two components on which the literature has focused. Specifically, for a group of 10 major EMs for which data are available through the BIS locational banking statistics, the

However, despite high and rising shares of external debt denominated in local currency, EMs remain more vulnerable to capital flow swings than advanced economies, as seen during the taper tantrum and in the Covid pandemic. This raises the question of what the distinguishing features of EMs are that make them more vulnerable, given that the role of currency mismatches has declined over time as documented above. [BIS \(2019\)](#) suggests that the answer to this question lies in the shallowness of financial markets in EMs compared to their advanced economy counterparts. [Figure 2](#) illustrates this along two dimensions: FX hedging markets and size of domestic institutional investors. [Figure 2a](#) shows that the size of the FX derivatives market for EM currencies is significantly smaller compared to AE currencies. This means that hedging exchange rate risk in EM currencies is much more limited in scope and more costly, even for global lenders and investors. [Figure 2b](#) shows that the size of domestic institutional investors, i.e. the size of the assets of pension funds and insurance companies in relation to GDP, is also much smaller in EMs than in advanced economies. As a consequence, EMs are more vulnerable to a pull-back and tightening in funding conditions from abroad as they do not have a strong domestic investor base to fall back on when foreign capital flows out.

## 2.2 Spillovers of foreign financial conditions to EMs

To understand the role played by currency of denomination of external debt in determining the sensitivity of EMs to external financial shocks, we conduct a panel analysis using cross-country data on investment and external borrowing by currency for 16 EMs and 8 AEs. We study how the response of investment to a US monetary tightening shock depends on the currency of denomination of external debt and how the effect differs between EMs and AEs. More specifically, we estimate a dynamic panel regression model specified as follows:

$$y_{i,t+4} - y_{i,t-1} = \alpha_y \Delta y_{i,t-1} + \alpha_{os} os_{it-1} + \alpha_{osr} osr_{it-1} + \beta_r \Delta r_{t-1} + \beta_\pi \pi_{t-1} \quad (2.1)$$

$$\beta_{os} * \Delta r_{t-1}^{us} * os_{it-1} + \beta_{osr} \Delta r_{t-1}^{us} * osr_{it-1} + \beta_X \Delta X_{i,t-1} + \alpha_t + \alpha_i + \epsilon_{i,t} \quad (2.2)$$

The model is estimated at quarterly frequency.  $y$  denotes the log of investment, measured as real gross fixed capital formation. The dependent variable is therefore the four quarter change in real investment.  $os$  and  $osr$  are measures of original sin and original sin redux respectively. We use data on currency composition of external debt liabilities from [Benetrix et al. \(2019\)](#) and measure  $os$  as the ratio of external debt liabilities denominated in USD to

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local currency share in corporate external debt more than doubles on average over the period 2018-2020 when indirect borrowing is taken into account.

GDP, while  $osr$  is measured as the ratio of non-USD denominated external debt liabilities to GDP, the bulk of which are in local currency.<sup>5</sup> Given the relatively high unconditional correlation between  $os$  and  $osr$  of around 0.7, we conduct a first stage regression of  $osr$  on  $os$ , and include the residuals from this first stage when estimating equation 2.2.  $\Delta r_{t-1}$  is a measure of the shock to the US policy rate computed using the narrative approach of Romer and Romer (2004) (updated to 2013 based on the latest available data).<sup>6</sup>  $X_{i,t-1}$  includes additional country level controls including lagged inflation and the policy rate (as well as US inflation and growth in specifications where time fixed effects are not used).

Table 1 presents the estimates. The estimates reported in Column 1.1 and 1.2 correspond to a simple OLS regression (with standard errors clustered by country), for EMs and AEs respectively. The subsequent two columns present estimates from models with richer specifications, including country fixed effects (Column 2) and country and time fixed effects (Column 3).

The estimates in Table 1 reveal three key results. First, higher degrees of original sin tend to lead to sharper declines in investment in EMs in response to a US monetary contraction ( $\beta_{os} < 0$ ). This is the canonical original sin effect that has been studied in the literature. Second, even after controlling for the original sin, higher local currency borrowing from abroad (relative to domestically sourced) also leads to a sharper decline in investment in response to the shock ( $\beta_{osr} < 0$ ). This to our knowledge is the first macro-level evidence in favor of the original sin redux hypothesis. Third, we find that for EMs, the impact of original sin is consistently higher than that of original sin redux, i.e.  $|\beta_{os}| > |\beta_{osr}|$ .<sup>7</sup> This indicates that while local currency borrowing does not prove to be a redemption from the original sin, it does yield an improvement. Fourth, we do not see a significant effect for either the original sin or its redux for AEs (Column 1.2). This suggests that despite borrowing substantially from abroad in both local and foreign currency, AEs are not as vulnerable to external shocks as EMs. The next section is devoted to developing a simple two country model that can help rationalize these results and derive policy implications.

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<sup>5</sup>We generate quarterly values from annual ones available in the original database through linear interpolation.

<sup>6</sup>The narrative approach uses the the Federal Reserve’s Greenbook forecasts which are only available with a significant lag, and hence the sample cannot include recent years. That said, we still believe that his offers the best monetary policy shock series in our setting. Alternatives including high frequency approaches such as Gertler and Karadi (2015) are less suited due to the low frequency of the macro data (quarterly) and debt data (annual) that we use.

<sup>7</sup>The difference between  $\beta_{os}$  and  $\beta_{osr}$  is also statistically significant for two out of the three specifications for EMs.

### 3 Model

The model is based on the asymmetric two country model developed by [Banerjee et al. \(2016\)](#) (BDL), which in turn is an open economy extension of [Gertler and Karadi \(2011\)](#). Figure 3 provides a diagrammatic representation of the model. The two countries are the EM, comprising a mass  $0 < n < 0.5$  of the world economy, and the AE, comprising the remaining mass of  $(1 - n)$ . Both economies feature households, capital producers, production firms, banks (financial intermediaries)<sup>8</sup> and a monetary authority. The EM borrows from the advanced economy in foreign or local currency. The model does not include a government sector for ease of exposition and does therefore not feature external borrowing through the government sector. However, we show that a more complex model where the government is borrowing from abroad and government financing conditions affect the private sector yields qualitatively equivalent results.

The remainder of this section focuses on describing the modeling of the sectors in each economy in detail and on discussing our calibration strategy to quantify the model. The extension of the baseline model including a government sector is presented in Section 6.

#### 3.1 The emerging market

##### 3.1.1 Household

EM households take consumption and labor supply decisions and trade foreign and domestic financial assets with the objective of maximizing the following utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{(C_t^e)^{1-\sigma}}{1-\sigma} - \frac{(H_t^e)^{1+\psi}}{1+\psi} \right] \quad (3.1)$$

where  $C_t^e$  is a consumption basket and  $H_t^e$  is labor supply.

Denote  $C_{e,t}^e$  and  $C_{c,t}^e$  to be the EM households' consumption of EM goods and AE goods. The consumption basket takes the following form:

$$C_t^e = [(\nu^e)^{\frac{1}{\eta}} (C_{e,t}^e)^{\frac{\eta-1}{\eta}} + (1 - \nu^e)^{\frac{1}{\eta}} (C_{c,t}^e)^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \quad (3.2)$$

where  $\eta$  is the cross-country elasticity of substitution between EM and AE goods.

The EM price index is given by:

$$P_t^e = [\nu^e (P_{e,t}^e)^{1-\eta} + (1 - \nu^e) (P_{c,t}^e)^{1-\eta}]^{\frac{1}{1-\eta}} \quad (3.3)$$

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<sup>8</sup>We use the word ‘‘banks’’ to represent the financial sector in general, which broadly includes bank finance and non-bank finance such as investment funds, institutional investors and retail asset managers.

The EM household budget constraint in nominal local currency terms is:

$$P_t^e C_t^e + S_t P_t^c B_t^e + \gamma_B (B_t^e - B_{SS}^e)^2 + P_t^e D_t^e = P_t^e W_t^e H_t^e + \Pi_t^e + R_{t-1}^c S_t P_{t-1}^c B_{t-1}^e + R_{t-1}^e P_{t-1}^e D_{t-1}^e + T_t^e \quad (3.4)$$

where  $S_t$  is the exchange rate, which is the price of the AE currency in terms of the EM currency so that an EM currency depreciation is an increase in  $S_t$ .  $B_t^e$  is the EM households' holding of the AE risk-free bond, which is denominated in AE currency and pays a nominal return of  $R_t^c$ .  $D_t^e$  is the domestic deposit in the EM banking system.  $W_t^e$  is the real wage rate.  $\Pi_t^e$  is the total nominal profit from EM firms and banks.  $T_t^e$  is a lump sum transfer from the government (monetary authority).  $B_{SS}^e$  is the steady state EM households' holding of the AE risk-free bond and  $\gamma_B$  is a parameter that introduces a small convex transaction cost in international portfolio adjustment for stationarity as in [Schmitt-Grohé and Uribe \(2003\)](#).

### 3.1.2 Capital goods producers

Capital producing firms in the EM buy back old capital from banks at price  $Q_t^e$  (in units of the consumption aggregator) and produce new capital from the final good in the EM economy subject to the following adjustment cost function:

$$\Gamma(I_t^e, I_{t-1}^e) = \varsigma \left( \frac{I_t^e}{I_{t-1}^e} - 1 \right)^2 I_t^e \quad (3.5)$$

where  $I_t^e$  is the EM investment in terms of the aggregate EM good.

The EM banks then rent the capital to production firms. Denote  $K_t^e$  as the capital stock of the EM with the law of motion given by:

$$K_t^e = I_t^e + (1 - \delta) K_{t-1}^e \quad (3.6)$$

### 3.1.3 Banks

The modeling of the banking sector follows [Gertler and Karadi \(2011\)](#). There is a mass  $n$  of competitive banks. Each period, a fraction  $1 - \theta$  of the banks exit and repatriate all their profits to households. The remaining fraction  $\theta$  continues to operate and accumulate net worth. To replace the exiting banks, the non-bank households are randomly assigned to be new banks, with a start up capital of  $\delta_T$  of existing banking capital injected by households, to keep the banking mass constant.<sup>9</sup> Banks are subject to an incentive constraint described

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<sup>9</sup>As in [Gertler and Karadi \(2011\)](#), this assumption of a turnover in the banking sector is needed to ensure that banks do not accumulate a large enough net worth which would make the leverage constraint irrelevant.

below. The net worth of bank  $i$  is denoted by  $N_{i,t}^e$ .

The banks raise their funds (liabilities) from two sources - loans from global banks and deposits in local currency from domestic household ( $D_t^e$ ). We denote the loans in the contract currency in real terms (CPI of EM) as  $V_{i,t}^e$ . Bank  $i$ 's balance sheet in local currency real terms is then given by:

$$N_{i,t}^e + (RER_t)^{ld} V_{i,t}^e + D_t^e = Q_t^e K_{i,t}^e + TB_t^e \quad (3.7)$$

where  $RER_t \equiv \frac{S_t P_t^c}{P_t^e}$  is the real exchange rate and  $ld$  (for liability dollarization) is an indicator which is equal to one if the loan is in foreign (AE) currency and zero if it is in local (EM) currency. The term  $TB_t^e$  represents a lump sum transfer from the government or the monetary authority.

Each period, the banker  $i$ 's real net worth is the return generated from last period investment, minus the debt repayment to AE banks and domestic depositors.

$$N_{i,t}^e = R_{k,t}^e Q_{t-1}^e K_{i,t-1}^e - (RER_t)^{ld} \frac{R_{b,t-1}}{(\pi_t^c)^{ld} (\pi_t^e)^{1-ld}} V_{i,t-1}^e - \frac{R_{t-1}^e}{\pi_t^e} D_{t-1}^e \quad (3.8)$$

where  $R_{k,t}^e$  is the real capital rate of return,  $R_{b,t-1}$  is the nominal interest rate charged by the AE banks,  $\pi_t^c \equiv \frac{P_t^c}{P_{t-1}^c}$  and  $\pi_t^e \equiv \frac{P_t^e}{P_{t-1}^e}$  are the AE and EM inflation rates.

### Incentive constraint

We model the financial friction following [Gertler and Karadi \(2011\)](#) as an incentive problem. Specifically, at the beginning of each period, the banker has the ability to abscond with a fraction  $\kappa^e$  of the assets. Therefore, lenders will not be willing to lend to the EM banks unless the following incentive compatibility constraint is satisfied.

$$J_{i,t}^e \geq \kappa^e Q_t^e K_{i,t}^e \quad (3.9)$$

where  $J_{i,t}^e$  is the value function of bank  $i$  at time  $t$ .

### Limits on domestic deposits as a source of funding

We limit the share of domestic deposits in the model as a simple way to capture financial sector under-development in EMs. Specifically, we assume that domestic deposits cannot be larger than  $\frac{\varphi_D - 1}{\varphi_D}$  of total liabilities, where  $\varphi_D \geq 1$  is an exogenous parameter. In equilibrium, deposits therefore amount to:

$$D_{i,t}^e = (\varphi_D - 1) RER_t^{ld} V_{i,t}^e \quad (3.10)$$

The maximization problem of EM banks is:

$$J_{i,t}^e = \max_{K_{i,t}^e, V_{i,t}^e, D_{i,t}^e} E_t \Lambda_{t+1|t}^e [(1 - \theta) N_{i,t+1}^e + \theta J_{i,t+1}^e] \quad (3.11)$$

subject to 3.7, 3.8, 3.9 and 3.10.  $\Lambda_{t+1|t}^e \equiv \beta (\frac{C_t^e}{C_{t-1}^e})^{-\sigma}$  is the stochastic discount factor of the household.

The aggregate net worth at any point of time is the sum of surviving banks and newly adjusted capital:

$$N_t^e \equiv \int N_{i,t}^e di = \theta [(R_{k,t}^e - (\frac{RER_t}{RER_{t-1}})^{ld} \frac{\tilde{R}_{b,t-1}}{\varphi_D}) Q_{t-1}^e K_{t-1}^e + (\frac{RER_t}{RER_{t-1}})^{ld} \frac{\tilde{R}_{b,t-1}}{\varphi_D} (N_{t-1}^e - TB_{t-1}^e)] + \delta_T Q_t^e K_{t-1}^e \quad (3.12)$$

where  $\tilde{R}_{b,t-1} = [\frac{R_{b,t-1}}{(\pi_t^e)^{ld} (\pi_t^e)^{1-ld}} + \frac{R_{e,t-1}}{\pi_t^e} (\varphi_D - 1)]$  is the average cost of funding for one unit of loan.

### 3.1.4 Production firms

The productions firms operate as in standard New Keynesian models. There are competitive intermediate firms and monopolistic final goods firms. A representative intermediate firm has the following production function:

$$Y_t^e = A_t^e (H_t^e)^{1-\alpha} (K_{t-1}^e)^\alpha \quad (3.13)$$

For each period, the rate of return on investment for the EM banks is:

$$R_{k,t}^e = \frac{R_{z,t}^e + (1 - \delta) Q_t^e}{Q_{t-1}^e} \quad (3.14)$$

where  $R_{z,t}^e$  is the rental rate on capital and  $\delta$  is the rate of depreciation of capital.

The competitive assumption yields the following demand functions for capital and labor:

$$MC_t^e (1 - \alpha) A_t^e (H_t^e)^{-\alpha} (K_{t-1}^e)^\alpha = W_t^e \quad (3.15)$$

$$MC_t^e (\alpha) A_t^e (H_t^e)^{1-\alpha} (K_{t-1}^e)^{\alpha-1} = R_{z,t}^e \quad (3.16)$$

where  $MC_t^e$  is the real marginal cost of production, the price at which intermediate goods firms sell their output.

Monopolistic final goods firms buy goods from the intermediate firms, re-package them

into differentiated goods, and sell them to domestic or foreign households in a monopolistically competitive setting. Several recent papers have emphasized the role of dollar invoicing in understanding the transmission of shocks across countries.<sup>10</sup> To capture this phenomenon, we allow the monopolistic firms to set two different prices, one for the domestic market in the EM currency and one for foreign markets in the foreign currency. Each of these prices are subject to the staggered setting in [Calvo \(1983\)](#), and the same random fraction  $1 - \varsigma$  of firms adjusts their prices each period for both currencies. This set up gives rise to two Phillips curves, one for domestic price inflation ( $(\pi_{e,t}^{PPI})$ ), and one for export price inflation ( $(\pi_t^{*ec})$ ).

$$\pi_{e,t}^* = \frac{\sigma_p}{\sigma_p - 1} \frac{F_{e,t}}{G_{e,t}} \pi_{e,t}^{PPI} \quad (3.17)$$

$$F_{e,t} = Y_{e,t} MC_{e,t} + E_t[\beta \varsigma \Lambda_{t,t+1}^e (\pi_{e,t+1}^{PPI})^\eta F_{e,t+1}] \quad (3.18)$$

$$G_{e,t} = Y_{e,t}^{ee} P_{e,t}^{ee} + E_t[\beta \varsigma \Lambda_{t,t+1}^e (\pi_{e,t+1}^{PPI})^{-1+\eta} G_{e,t+1}] \quad (3.19)$$

$$(\pi_{e,t}^{PPI})^{1-\eta} = \varsigma + (1 - \varsigma)(\pi_{e,t}^*)^{1-\eta} \quad (3.20)$$

$$\pi_t^{*e,c} = \frac{\sigma_p}{\sigma_p - 1} \frac{F_t^{e,c}}{G_t^{e,c}} \quad (3.21)$$

$$F_t^{e,c} = Y_t^{ec} MC_t^e + E_t[\zeta \Lambda_{t+1}^e \pi_{t+1}^{ec} F_{t+1}^{ec}] \quad (3.22)$$

$$G_t^{ec} = Y_t^{ec} P_t^{ec} RER_t + E_t[\zeta \Lambda_{t+1}^e \pi_{t+1}^{ec} (\sigma_p - 1) G_{t+1}^{ec}] \quad (3.23)$$

$$(\pi_{e,t}^{ec})^{1-\eta} = \varsigma + (1 - \varsigma)(\pi_{e,t}^{*ec})^{1-\eta} \quad (3.24)$$

where  $\sigma_p$  is the cross-good elasticity among goods within the country.  $\pi_{e,t}^{PPI}$  is the PPI inflation rate.

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<sup>10</sup>See for instance [Akinici and Queralto \(2018\)](#), [Gopinath et al. \(2020\)](#) and [Cook and Patel \(2020\)](#).

### 3.1.5 Monetary policy and exchange rate

The central bank sets the domestic currency risk free rate following a simple inertial Taylor rule of the form:

$$R_t^e = \lambda_r^e R_{t-1}^e + (1 - \lambda_r^e) [\lambda_\pi^e (\pi_t^e - \pi_{ss}^e) + \lambda_y^e (Y_t^e - Y_{ss}^e)] + \epsilon_t^e \quad (3.25)$$

The central bank is thus assumed to respond to deviations of inflation and output from their steady state levels in an inertial way, captured by the presence of the lagged policy rate in the reaction function. We therefore assume that the central bank responds to external shocks and exchange rate fluctuations only to the extent that they affect domestic inflation and output, in line with the standard inflation targeting paradigm.

Changes in the domestic policy rate are transmitted to the economy also through the exchange rate, which is determined by a standard uncovered interest rate parity condition derived from the household's Euler condition:

$$E_t \left( \frac{S_{t+1}}{S_t} \right) = \frac{R_t^e}{R_t^c} \quad (3.26)$$

## 3.2 The advanced economy

AE variables are superscripted with  $c$ . The household, capital producer, production firm sectors and monetary policy in the AE are modeled in the same way as in the EM. The modeling of the banking sector is different and is described below.

### 3.2.1 Banks

The banks directly receive funding from deposits of AE households, invest in the domestic capital stock and make loans to EM banks.

For the representative AE bank  $j$ , the balance sheet in real terms is given by:

$$N_{j,t}^c + D_{j,t}^c = Q_t^c K_{j,t}^c + V_{j,t}^e / (RER_t)^{1-l_d} \quad (3.27)$$

where  $N_{j,t}^c$  is the net worth,  $D_{j,t}^c$  are deposits from the domestic households in AE and  $Q_t^c K_{j,t}^c$  is the investment in the capital stock in the AE.

Each period, bank  $j$ 's real net worth is the return generated from last period investment in domestic capital stock and EM loans, less the debt repayment to domestic depositors:

$$N_{j,t}^c = R_{k,t}^c Q_{t-1}^c K_{i,t-1}^c + \frac{R_{b,t-1}}{(\pi_t^c)^{ld} (\pi_t^e)^{1-ld}} V_{i,t-1}^e / (RER_{t-1})^{1-ld} - \frac{R_{t-1}^c}{\pi_t^c} D_{t-1}^c \quad (3.28)$$

### Incentive constraint

The AE banks face the same type of incentive constraint as EM banks do:

$$J_{j,t}^c \geq \kappa_t^c (Q_t^c K_{j,t}^c + V_{j,t}^e / (RER_t)^{1-ld}) \quad (3.29)$$

The maximization problem of the AE banks is:

$$J_{j,t}^c = \max_{K_{j,t}^c, V_{j,t}^e, D_{j,t}^c} E_t \Lambda_{t+1|t}^c [(1 - \theta) N_{i,t+1}^c + \theta J_{i,t+1}^c] \quad (3.30)$$

subject to 3.27, 3.28 and 3.29.

Similar to 3.12, AE bank net worth is given by:

$$N_t^c \equiv \int N_{j,t}^c dj = \theta [(R_{k,t}^c - \frac{R_{t-1}^c}{\pi_t^c}) Q_{t-1}^c K_{t-1}^c + \frac{n}{1-n} (\frac{R_{b,t-1}}{(\pi_t^c)^{ld} (\pi_t^e)^{1-ld}} - \frac{R_{t-1}^c}{\pi_t^c}) (\frac{RER_{t-1}}{RER_t})^{1-ld} V_{t-1}^e + \frac{R_{t-1}^c}{\pi_t^c} N_{t-1}^c] \quad (3.31)$$

The first order condition w.r.t.  $V_{j,t}^e$  is:

$$\Lambda_{t+1|t}^c [(1 - \theta) + \theta J_{j,t+1}^{c'}] [\frac{R_{b,t}}{(\pi_{t+1}^c)^{ld} (\pi_{t+1}^e)^{1-ld}} (\frac{RER_t}{RER_{t+1}})^{1-ld} - \frac{R_t^c}{\pi_{t+1}^c} + \vartheta_t] = \kappa_t^c \gamma_t^c \quad (3.32)$$

where  $\gamma_t^c$  is the Lagrangian multiplier associated with 3.29.  $\vartheta_t$  introduces a stochastic component to the return of AE banks in investing in EM. This helps us to model capital inflow and outflow shocks to the EM. It can be interpreted as a preference or non-monetary return shock to EM investments.<sup>11</sup>

## 3.3 Taking stock of the key mechanisms in the model

### 3.3.1

### 3.3.2

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<sup>11</sup>This is isomorphic to an UIP shock in the exchange rate determination literature. See Kollmann (2001), Devereux and Engel (2002), Engel (2014), Itskhoki and Mukhin (2021) and Engel and Wu (2018).

### 3.4

Table 2 summarizes the different channels through which a foreign financial shock (like a monetary contraction in the AE), which will be the focus of the analysis in the next section, affects EM GDP in the model. There are two main channels at work, the traditional trade channel and the financial channel. First, the shock leads to a contraction in AE aggregate demand, which spills over to cause a contraction in EM aggregate demand due to a decline in imports (Column 1a). Next, via the uncovered interest rate parity condition (equation 3.26), the shock causes the EM currency to depreciate, boosts net exports through an improvement in price competitiveness (Column 1b). Since these two mechanisms affect EM GDP in opposite directions, the overall effect through the trade channel is unclear a priori.

A foreign financial shock further adversely affects EM financial conditions and GDP through direct credit supply effects and balance sheet effects of the exchange rate. Specifically, a monetary tightening in the AE induces a tightening of the balance sheet constraints of AE financial institutions, leading to a cut back of credit supply to the EM, inducing higher borrowing rates and ultimately dampening investment (column 2a). At the same time, the EM currency depreciation induced by the AE financial tightening increases the local currency value of liabilities and lowers EM banks' net worth in the OS case, while it lowers the local currency value of assets and lowers the net worth of AE lenders in the OSR case (column 2b). These balance sheet effects of the exchange rate induce further credit supply cut backs, further dampening investment under both the OS and the OSR scenario.

As shown in the next section, the overall effect on EM GDP depends on the relative strengths of these channels, as well as policy responses to the shock in the EM.

### 3.5 Model parameterization, shocks and scenarios

The model is parameterized to quarterly frequency. Table 3 reports the parameters used. Our focus is on understanding the qualitative implications of the model rather than a precise quantitative assessment of the various channels at play. That said, our calibration closely follows previous papers, in particular Banerjee et al. (2016) and Gertler and Karadi (2011).

Specifically, the discount factor ( $\beta$ ) is chosen to ensure a steady state real rate of return of 4% in either economy. The size of the EM in the global economy  $n$  is fixed at 0.2.<sup>12</sup> The cross-country elasticity of substitution  $\eta$  is set at 2, whereas the within country elasticity of substitution ( $\sigma_p$ ) is fixed at 6, implying a steady state markup of 20%. The Calvo parameters ( $\varsigma$ ) are set to 0.85, implying that prices are sticky on average for a year and a half.

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<sup>12</sup>The EM is therefore to be interpreted as the group of EMs that rely on external sources of funding, rather than a single EM. Similarly, the advanced economy represents the group of AEs rather than a single AE.

We follow [Gertler and Karadi \(2011\)](#) for the calibration of the banking sector parameters. In particular, the survival rate of banks ( $\theta$ ) is set at 0.97, the steady state value of the leverage constraint parameter ( $\kappa$ ) is 0.38, and the capital injection share of new banks ( $\delta_T$ ) is 0.004. The other parameters, such as the depreciation rate of capital, are fixed at their conventional values from the literature.

The model is solved using log-linearization, assuming that the constraint is always binding. Given our primary interest of understanding the implications of shocks that lead to capital outflows and a depreciation of the EM currency, we build the simulation exercise around a 100 basis points increase (tightening) in the advanced economy risk free rate as the main shock.

We compare three regimes in the simulation exercises to study the role of currency denomination of external debt on the one hand, and the role of external vs domestic debt on the other.

- Foreign currency external debt (OS:  $ld = 1, \varphi_D = 0$ )
- Local currency external debt (OSR:  $ld = 0, \varphi_D = 0$ )
- Domestic deposits (75% domestic, 25% external local currency deposits:  $ld = 0, \varphi_D = 0.75$ )

## 4 Original sin vs original sin redux

In order to flesh out the different channels and to illustrate the mechanisms of the model, we simulate the AE monetary tightening for different versions of the model: (i) without financial friction in the AE financial sector, (ii) with financial friction in the AE financial sector and (iii) without exchange rate feedback effects on borrower or lender balance sheets respectively under the OS and the OSR scenario. The latter exercise can be seen as a simple test of the implications of financial sector FX hedging on the dynamics of the model.

### 4.1 Absence of advanced economy financial friction

In order to illustrate the role of financial constraints in the AE banking sector, we first analyze in this section the model dynamics when such constraints are absent, i.e.  $\kappa_t^c = 0$ . [Figure 4](#) plots the IRFs (% deviation from the steady-state) for the case of loans from the AE lenders in foreign currency (original sin, OS:  $ld = 1$ , blue lines) and in local currency (original sin redux, OSR:  $ld = 0$ , red lines) in response to a 100 basis points monetary tightening shock in the AE.

Under both scenarios, the AE monetary tightening is associated with a drop in AE output, a decline in bank net worth and an EM currency depreciation.<sup>13</sup> The impact on EM financial conditions and real economy however differ significantly under OS compared to OSR. When the loans are denominated in foreign currency (OS), the EM experiences a significant tightening in financial conditions. The currency depreciation harms the EM banks' net worth, since their assets are denominated in local currency whereas liabilities are in foreign currency. This leads to an increase in borrowing costs, falling asset prices, a credit contraction, and consequently a sharp fall in investment. EM GDP drops substantially, by almost 1.5% at the peak, driven primarily by the drop in real investment. Inflation rises on impact reflecting the effect of exchange rate depreciation through the pass-through channel, but then falls as the real economy tanks.

The charts show that when loans are denominated in local currency, EM GDP increases relative to the steady-state level on impact. This reflects the conventional trade channel of the exchange rate - the increase is mainly due to the expenditure switching effect that tends to increase EM net exports. The financial channel of the exchange rate is largely absent in this case. On the AE side, GDP falls due to a sharp contraction in aggregate demand caused by the monetary tightening. This leads to a significant reduction in AE banks' net worth. However, since there is no financial friction in the AE banking sector, the spread of the lending rate over the policy rate does not change. As a result, the borrowing rate faced by EM banks is effectively unchanged, because the increase in the AE interest rate is compensated by the expected appreciation of the EM currency subsequently.

To summarize, the results of this exercise illustrate the strong macro-financial repercussions of the financial channel of exchange rates operating through EM borrower balance sheets, which outweighs the trade channel of exchange rates under OS. In the absence of financial frictions on AE balance sheets, local currency debt (OSR) largely insulates the EM economy from the financial channel by moving the exchange rate vulnerability from the balance sheet of the financially constrained EM banking sector to the unconstrained AE financial sector. This leads to a more stable financial sector overall. This is consistent with the traditional prescription of promoting debt liability denomination in local currency to enhance resilience of EMs to capital flow swings. However, as we show next, the picture changes substantially once we allow take a global perspective on financial frictions, allowing them to be present in both EM and AE banking sectors.

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<sup>13</sup>Note that the impact of the 100 bps monetary policy shock on the AE policy rate itself is smaller at about 80 basis points, reflecting the endogenous response of monetary policy to the induced drop in output and inflation through the Taylor rule.

## 4.2 Presence of advanced economy financial friction

We replicate the simulation exercise for the case when financial frictions are also present in the AE banking sector in addition to the EM banking sector. We set  $\kappa_t^c = 0.38$ , which is the same as [Gertler and Karadi \(2011\)](#). Figure 5 plots the impulse responses for two cases where there is a 100 basis point monetary tightening shock in the AE in the presence of financial frictions on the side of both AE lenders and EM borrowers. 1)  $ld = 1$  (OS) and 2)  $ld = 0$  (OSR), the local (EM) currency debt or “original sin redux” case.

The blue line in Figure 5, which represents the “original sin” case, behaves similar to the blue line in Figure 4, albeit not identical due to the presence of financial frictions in AE. It features a strong reduction in EM GDP by more than 3% that is as before driven by a large drop in EM investment.

More importantly, the IRFs of the OSR case behave very differently from the case when there is no AE financial friction. Because AE banks now also face a financial constraint, the reduction in their net worth brought about by the AE monetary tightening translates into a reduction in credit supply to EMs, pushing EM borrowing rates up and EM asset prices and bank net worth down. The unexpected EM currency depreciation erodes the local currency loan return for AE banks, which further impairs AE banks’ net worth and therefore pushes up the lending rate to EM banks even more. In other words, the valuation effects of exchange rate fluctuations on EM bank balance sheets have migrated to AE bank balance sheets.

Thus, once we consider the implications of local currency borrowing in a general equilibrium setting with financial frictions in financial sectors being present globally, local currency borrowing does not imply a redemption from original sin. Also under local currency borrowing, there are significant spillovers from a tightening of AE financial conditions to EM financial conditions as financially constrained AE banks cut back credit supply to EMs. Also, one way or the other, the currency mismatch problem remains in the global financial system, either on the lenders’ or on borrowers’ balance sheets.<sup>14</sup>

## 4.3 Exchange rate amplification effects and FX hedging

In the presence of financial frictions on the side of AE lenders, the overall impact of a monetary tightening on financial conditions in EMs is the result of two effects: (i) the direct effect of the monetary tightening on the AE lender balance sheet; and (ii) the amplification effect of the associated depreciation of the EM currency working through the borrower (OS)

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<sup>14</sup>Moreover, by considering a first order approximation around the non-stochastic steady state, our model does not capture the fact that exchange rate risk on the AE bank balance sheet with  $ld = 0$  is likely to lead to a "precautionary saving" type effect, whereby the AE bank would charge a higher interest rate on EM currency as compared to dollar debt, as is often observed in the data.

or lender (OSR) balance sheet. In order to disentangle the two effects, we replicate the simulations switching off the exchange rate feedback effect on borrower or lender balance sheets.

The results of this exercise are shown in Figure 6. The solid lines replicate the baseline results shown in the previous sub-section, the broken lines show the effects when exchange rate feedback effects through borrower and lender balance sheets are switched off. The figure reveals that both under OS and OSR the amplification effects through exchange rate depreciation are considerable. The effects are materially reduced when the financial channel of the exchange rate is deactivated, but they remain economically significant. Thus, seen from a different perspective, the results also suggest that the significance of the spillover effects of an AE monetary tightening do not hinge on the balance sheet effects of exchange rate depreciation alone. Even when the exchange rate amplification effects are switched off, the spillovers are sizable for both OS and OSR, being as before somewhat smaller in the latter case.

This finding also implies that the existence of macro-financial repercussions of an AE monetary tightening qualitatively do not depend on the assumed extent of hedging of exchange rate risk. The analysis so far assumes no hedging so that an exchange rate change fully impacts economic agents, in particular financial intermediary balance sheets, through currency mismatches. While hedging markets in EM currencies are less liquid than those in AE currencies as shown before, it is still reasonable to assume that some part of exchange rate risk in EMs is hedged, not least since banks are often required to hedge such risk by regulation. The results shown in Figure 6 suggest that even in the unrealistic extreme case of full hedging of exchange rate risk on intermediary balance sheets, the spillovers to EMs remain considerable.<sup>15</sup>

## 5 Policy implications

Having established the spillovers of a foreign financial tightening to EMs, we next delve into an analysis of policy implications. We assess the usefulness of additional policy to address financial spillovers, specifically of FX intervention and capital flow management measures, the role of longer run financial development to address the root cause of EMs' vulnerability to

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<sup>15</sup>Assuming away exchange rate feedback effects on balance sheets is of course an extremely simplistic characterization of hedging policies. In reality, hedging will not be complete. The real world situation is therefore somewhere between the two polar cases of no hedging, which we is our baseline considered so far, and full hedging. Moreover, hedging comes at a cost and the exchange rate risk will ultimately have to be borne by someone. That said, the simplistic perspective taken here is still fit for purpose to make the general point. A fully fledged modeling and integration of hedging is beyond the scope of this paper and is therefore left for future research.

spillovers, and also the implications of OSR for the stabilizing capacity of domestic monetary policy.

## 5.1 FX intervention and capital flow management measures

In our model, monetary policy is a rather ineffective tool for dealing with external shocks in EMs. This is because a domestic monetary policy easing affects output through two channels that tend to offset each another. The first is the standard new Keynesian aggregate demand channel, which tends to boost aggregate demand and increase output. But the monetary easing also leads to a depreciation of the exchange rate, which tends to reduce EM or AE bank net worth and generate a credit contraction that depresses investment and output. This increases the value of additional policy tools in the toolkit of central banks, such as FX intervention, capital flow management measures and macroprudential policies (see for instance [Chen et al. \(2021\)](#) and [Davis et al. \(2021\)](#)). Indeed, EM central banks have systematically resorted to FX intervention, macroprudential tools and capital flow management tools to address the challenges from capital flow and exchange rate swings ([BIS \(2019\)](#)). In this sub-section we analyze the value of such tools from the perspective of our model. Specifically, we assess the effectiveness of sterilized FX intervention and a capital flow tax as additional policy instruments to cushion the fallout of external shocks from the perspective of our model, focusing on the case of original sin redux (external borrowing in local currency).<sup>16</sup>

### 5.1.1 FX intervention

To introduce a role for FX intervention, we need to describe how the economy responds to the change in foreign exchange reserves (FX reserves), and how FX reserves respond to economic conditions. We model (sterilized) FX intervention as in [Devereux and Yetman \(2014\)](#), [Chang \(2018\)](#) and [Arce et al. \(2019\)](#), assuming that FX intervention is conducted with the goal to stabilize the exchange rate around its steady state level. Specifically, we assume that the monetary authority conducts FX intervention by adjusting FX reserves in response to the exchange rate with the following rule:

$$\Delta FR_t = \left( \frac{RER_t}{RER_{SS}} \right)^x - 1 \quad (5.1)$$

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<sup>16</sup>The capital flow management tax can be interpreted as a form of macroprudential policy. An alternative macroprudential policy would be one which targets the capital requirement of domestic banks. Given our focus on foreign shocks and foreign capital flows and the absence of domestic deposits and investors in the baseline scenario, our model is better equipped to analyze capital flow measures as opposed to domestically oriented macroprudential measures.

where  $RER_{SS}$  denotes the steady state  $RER$  and  $\chi$  is a parameter that governs the strength of the intervention.

We further assume that changes in FX reserves are financed by lump sum taxes or transfers, which is equivalent to sterilization operations conducted in the form of sales and purchases of sterilization bonds that drain or inject liquidity. The two lump sum taxes on households and banks we described above serve this purpose, so we can express the change in FX reserves in the following way:

$$\Delta FR_t = FR_t - R_{t-1}^c FR_{t-1} = (1 - \Psi)T_t^e + \Psi TB_t^e \quad (5.2)$$

where  $FR_t$  is the level of FX reserves at time  $t$  and  $\Psi$  is the share of reserves that is distributed to the banking sector. For example, if  $\Psi=0$ , then all the reserves accumulation/decumulation is financed through sterilization operations with the households.

Figure 7 shows the impulse responses for an AE monetary tightening shock when FX intervention is activated. We consider two types of FX interventions, namely the case when the sterilization operation targets households ( $\Psi = 0$ ) and alternatively the case when it targets the banking sector ( $\Psi = 1$ , Equation 5.2). When households are the counterparty of the sterilization operation, the intervention is essentially ineffective. The IRFs with FX intervention (red lines) are basically identical with those when there is no intervention (blue lines, not visible as superimposed by red lines). This is consistent with the finding of Backus and Kehoe (1989) in which FX intervention is ineffective in a frictionless market.<sup>17</sup>

The effectiveness of FX intervention increases substantially when sterilization operations are conducted with the banking sector (yellow lines), as is normally the case in reality. GDP falls much less in this case. The intervention also succeeds in dampening the depreciation of the exchange rate. The main effect of the intervention is however the stabilization of EM banks' balance sheets through the sterilization operation. The sterilized FX intervention in response to a foreign financial tightening involves selling foreign reserves and transferring the proceeds to banks. In a model with sterilization bonds, the FX intervention in this case would be offset by purchases of sterilization bonds. The associated injection of liquid funds frees up resources in the EM banking sector, buffering the drop in net worth and enhancing its lending capacity. The FX intervention is effective here as it relaxes the financial constraint faced by EM banks precisely when an exogenous shock tightens it. The smaller reduction in banking net worth reduces the fall in investment and ultimately of GDP. This “debt limit channel” of FX intervention is also discussed in Chang and Velasco (2017), Chang (2018),

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<sup>17</sup>The slight difference in the impulse responses is due to the fact that the household portfolio market is not exactly frictionless in our model, but it has a very small portfolio adjustment cost to ensure stationarity (Schmitt-Grohé and Uribe (2003)).

Cavallino and Sandri (2020) and Hofmann et al. (2019).

A couple of caveats regarding the use of FX intervention as a policy tool are in order. First, our model highlights the benefits of FX intervention, but does not capture its costs. For instance, FX reserves typically entail a lower rate of return on average than alternative investments, and this opportunity cost should be factored into any analysis on the cost and benefits of holding reserves for intervention purposes. Second, our model also abstracts from moral hazard concerns that may arise when the central bank makes frequent use of FX intervention, leading to excessive risk taking by private agents (see for instance McKinnon (2000)). It may also hamper market development and incentivize private agents to continue to maintain unhedged FX exposures.

### 5.1.2 Capital flow tax

We next consider the effectiveness of capital flow measures in cushioning the impact of an AE monetary tightening. We illustrate this point by modeling capital flow measures through a time varying tax on cross-border capital flows to the EM. The tax takes the following form:

$$\tau_t^{inflow} = \tau_0 \left( \frac{V_t^e}{V_{steadystate}^e} - 1 \right) \quad (5.3)$$

This implies that the tax on capital inflows is an increasing function of the total capital inflow into the EM ( $V_t^e$ ) relative to its steady state value ( $V_{steadystate}^e$ ). Therefore, during episodes of capital outflows, the tax rate decreases to offset the effects of the outflow shock to some extent. Figure 8 shows that having such a tax in place can help cushion the impact of the shock by mitigating the degree to which borrowing costs in the EM rise and depress investment and output. Similar to the case of FX intervention, our results for the capital flow tax are merely geared towards illustrating the potential benefits of having the tool in place, rather than a precise cost-benefit analysis, for which we would have to model the costs of having such taxes in place more realistically.

## 5.2 Financial development

Carstens and Shin (2019) argue that developing a strong domestic investor base is key for EMs to overcome vulnerability to capital flow volatility in the long run. CGFS (2019) makes the same argument and in addition points to the need to develop deeper currency hedging markets to reduce vulnerability to exchange rate swings. Our analysis in section 4.3 supports the latter notion, showing that elimination of exchange rate amplification effects through intermediary balance sheets reduces spillovers, albeit it does not eliminate them. We now

assess the former point on the role of the size of the domestic investor base.

In Figure 9 we compare the effects of an AE monetary tightening shock (100 basis points) in an OSR scenario with 75% of the EM bank funds sourced from domestic deposits (red lines) compared to the baseline OSR scenario with no domestic deposits (blue lines). In both cases, AE GDP and banks' net worth reductions are similar. However, the borrowing rate that the EM faces is much lower in the case with domestic deposits. The smaller increase in the borrowing cost translates into a small reduction of EM banks' net worth and investment, resulting in a smaller drop in EM GDP.

The reduction in the vulnerability of EMs to foreign shocks when the domestic investor base is larger occurs via two channels. First, domestic investors evaluate their returns in the domestic currency. As a result, there is no currency mismatch problem on either the borrower or the lender's balance sheet. Second, lending from the domestic investor base to the domestic firm is only subject to one layer of financial frictions, namely those involving the domestic banks. On the other hand, lending from foreign investors is subject to two layers of financial frictions - those involving the foreign and the domestic banks respectively. Since the reduction in credit supply in the wake of an AE monetary tightening is to a significant extent transmitted through the financial constraints of the AE banking sector, reducing dependence on this source of funding also reduces vulnerability to foreign financial shocks. Assuming financial frictions to be more stringent in international borrowing as opposed to domestic borrowing (as assumed by [Akinci and Queralto \(2018\)](#)) would therefore further increase the benefits of a larger domestic investor base.

The beneficial effects of a deeper domestic investor base suggested by the analysis in this section should not be interpreted as supporting financial autarky. They should rather be seen as supporting policies that promote deep and liquid financial markets which allow EM borrowers to diversify sources of funding and provide hedging opportunities to better cope with foreign financial shocks. For instance, a large domestic investor base that also invests in foreign assets benefits EM borrowers in at least two ways. First, it allows EM borrowers to shift sources of funding from foreign to local markets in the face of external shocks. This is particularly valuable as a cushion during episodes characterized by global cross-border capital flow retrenchment. Second, domestic investors investing abroad form a natural counter-party for foreign lenders or EM financial intermediaries looking to hedge against depreciations of the EM currency, since the former are long foreign currency and short local currency. They therefore promote the development of FX derivatives markets that enable access to the benefits of hedging currency exposures illustrated in Figure 6.<sup>18</sup>

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<sup>18</sup>Indeed, as argued by [Chan-Lau \(2005\)](#) for the case of Chile, hedging motives of institutional investors have played an important role in the growth of FX derivatives markets.

### 5.3 Domestic monetary transmission

While the focus of the discussion is on spillovers from foreign monetary shocks, the currency denomination of borrowing from abroad and the strength of the domestic investor base may also affect the transmission of domestic monetary policy and hence the ability of the domestic central bank to conduct effective stabilization policy. We address this question by simulating the effect of a domestic monetary policy shock under the OS and the OSR scenario as well as under different assumptions about the size of the domestic institutional investor base.

Figure 10 shows, for the case of a domestic policy rate cut of 100 basis points, that relative to foreign currency external borrowing (OS), domestic currency external borrowing (OSR) leads to a significant strengthening in the transmission of domestic monetary policy to output. This is because the domestic policy rate cut leads to a sharp depreciation of the EM currency on impact, which is subsequently reversed in the following quarters. This reversal translates into an appreciation of the EM currency beginning in the period right after the shock. In anticipation of this appreciation, foreign lenders reduce the premium charged on local currency loans since they gain from exchange rate movements. Consequently, credit to the real economy expands more in the OSR case, leading to a stronger boost to GDP.

Finally Figure 10 further shows that a large domestic investor base not only makes the economy less vulnerable to foreign shocks, but that it also increases the strength of the transmission of domestic monetary policy to domestic output and investment. This is because with a larger domestic investor base, a larger fraction of EM banks' funding is linked directly to, and can be influenced by the changes in the domestic policy rate. This enhances the effectiveness of domestic monetary policy.<sup>19</sup>

## 6 Original sin redux in a model with sovereign debt

Our baseline model illustrates the implications of OS and OSR when external borrowing is done by the private sector of the economy to finance real investment. This provides a clear link between external borrowing and the real economy. This modeling approach abstracts, for ease of exposition, from the fact that it was in particular EM sovereigns who increased their borrowing in local currency from abroad over the past couple of decades. In this section, we consider an extension of the model where it is the sovereign who can borrow from abroad in local currency while the private sector borrows in foreign currency, and reexamine the

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<sup>19</sup>A similar observation is also made by Obstfeld (2015), who argues that under the GFC, domestic monetary policy was less effective since long-term rates were affected by the GFC's influence on global borrowing costs.

consequences for the effects of foreign monetary shocks on domestic financial conditions and output.

Unlike the corporate sector, we assume that the government borrows directly from the AE bank in either domestic or foreign currency. A schematic representation of this augmented model is given in Figure 11. We model the fiscal side in the spirit of [Kumhof and Laxton \(2013\)](#), abstracting from endogenous sovereign debt and consider a case where the government raises a fixed amount of debt from foreign banks each period, in either local or foreign currency.

To describe how the fiscal sector interacts with the private sector, we start by setting out the fiscal rule (or equivalently the government budget constraint). The fiscal government's surplus each period is:

$$surplus_t \equiv \tau_t + \underbrace{B_t^{Ge}(RER_t)^{ldgovt}}_{\text{new debt}} - \underbrace{B_{t-1}^{Ge} \frac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt} (\pi_t^e)^{1-ldgovt}} \left( \frac{RER_t}{RER_{t-1}} \right)^{ldgovt}}_{\text{debt repayment}} \quad (6.1)$$

where  $\tau_t$  is the tax revenue from taxing firm profits,  $B_t^{Ge}$  is the amount of government debt in period  $t$  and  $ldgovt$  is an indicator to indicate whether the contract is denominated in foreign currency or local currency (with  $ldgovt = 0$  denotes local currency and  $ldgovt = 1$  denotes foreign currency). The government taxes firm profits for the repayment of the debt. Its fiscal/tax policy is assumed to follow a simple rule:

$$surplus_t = \alpha_1 + \alpha_2 \ln(Y_t^e - Y_{ss}^e) \quad (6.2)$$

where the parameter  $\alpha_2$  governs the degree of cyclical policy.<sup>20</sup>

The AE bank incentive constraint now becomes:

$$J_{j,t}^c \geq \kappa^c(Q_t^c K_{j,t}^c) + \kappa_t^{c,EM}(x_t^{EM})(V_{j,t}^e / (RER_t)^{1-ld} + B_{j,t}^{Ge} / (RER_t)^{1-ldgovt}) \quad (6.3)$$

and the AE bank net worth equation becomes

$$N_t^c = \theta \left\{ \left( R_{k,t}^c - \frac{R_{t-1}^c}{\pi_t^c} \right) Q_{t-1}^c K_{t-1}^c + \frac{n}{1-n} \left[ \left( \frac{R_{b,t-1}}{(\pi_t^c)^{ld} (\pi_t^e)^{1-ld}} - \frac{R_{t-1}^c}{\pi_t^c} \right) \left( \frac{RER_{t-1}}{RER_t} \right)^{1-ld} V_{t-1}^e \right] \right. \\ \left. + \frac{n}{1-n} \left[ \frac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt} (\pi_t^e)^{1-ldgovt}} - \frac{R_{t-1}^c}{\pi_t^c} \right] \left( \frac{RER_{t-1}}{RER_t} \right)^{1-ldgovt} V_{t-1}^{Ge} \right] + \frac{R_{t-1}^c}{\pi_t^c} N_{t-1}^c \} \quad (6.4)$$

We assume  $\kappa$  on EM assets is a function of EM variables ( $x_t^{EM}$ ) and depends linearly on

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<sup>20</sup>Equation 6.1 and equation 6.2 can be combined to yield the tax revenue (tax rate), which is the main instrument for the fiscal authority.

the deviation of repayment to GDP from steady state that the sovereign needs to make with  $\kappa_t^{c,EM}(x_t^{EM} = 0) = \kappa_t^c$ , i.e.:

$$x_t^{EM} = B_{t-1}^{Ge} \frac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt} (\pi_t^e)^{1-ldgovt}} \left( \frac{RER_t}{RER_{t-1}} \right)^{ldgovt} - B_{SS}^{Ge} \frac{R_{SS}^{govt}}{(\pi_{SS}^c)^{ldgovt} (\pi_{SS}^e)^{1-ldgovt}} \left( \frac{RER_{SS}}{RER_{SS}} \right)^{ldgovt} \quad (6.5)$$

The introduction of this time varying  $\kappa$  gives rise to a higher EM spread when the sovereign repayment is high, which is consistent with the data.<sup>21</sup>

$$\kappa_t^e = F \left[ \underbrace{\frac{B_{t-1}^{Ge} \frac{R_{t-1}^{govt}}{(\pi_t^c)^{ldgovt} (\pi_t^e)^{1-ldgovt}} \left( \frac{RER_t}{RER_{t-1}} \right)^{ldgovt}}{Y^e}}_{\text{repayment}_t^{govt} / \text{GDP}} - \underbrace{\frac{B_{SS}^{Ge} \frac{R_{SS}^{govt}}{(\pi_{SS}^c)^{ldgovt} (\pi_{SS}^e)^{1-ldgovt}} \left( \frac{RER_{SS}}{RER_{SS}} \right)^{ldgovt}}{Y_{SS}^e}}_{\text{steady state repayment}_t^{govt} / \text{GDP}} \right] \quad (6.6)$$

## 6.1 Sovereign external borrowing without feedback to the private sector

Throughout the section, we assume that private sector borrowing is denominated entirely in foreign currency. We first consider the benchmark case where there is no direct feedback between the sovereign and the private sector, i.e. we set  $\alpha_2 = 0$  and keep  $\kappa^e$  time invariant. Figure 12 shows the impulse response to a foreign monetary tightening for the two cases of EM sovereign external borrowing in foreign currency (blue lines) and in local currency (red lines). We note that the net worth of global banks falls more when they lend to the EM government in local currency. This is on account of the fact that they have a currency mismatch on their balance sheet when lending in the EM currency, which lowers the value of their loan (assets, which are in local currency) as opposed to liabilities (which are in dollars) when the EM currency depreciates. On the other hand, the consequences of currency mismatch when borrowing in dollars are negligible for the EM government, since unlike the EM banks, they are not financially constrained under this case of no feedback to the private sector.

Consequently, EM GDP falls more when the government is borrowing in local currency, due to the larger fall in net worth of global banks which leads to larger credit contraction to the EM banks. However, the borrowing rate rises less in this case, since the expected appreciation of the EM exchange rate starting in the period after the shock makes global

<sup>21</sup>See Aoki et al. (2016) for a recent example of a time varying  $\kappa$  in the parameterized form. There are multiple ways to microfound this constraint. We provide a simple model in Appendix A

banks willing to lend to the EM government in local currency at a lower rate.<sup>22</sup>

## 6.2 Sovereign external borrowing with feedback to the private sector

The ability to impose taxes and transfers gives the sovereign sector the unique ability to divert resources from other parts of the economy to cover its fiscal needs. As a result, sovereign funding conditions can be expected to have a significant bearing on the funding conditions of the private sector.<sup>23</sup> Motivated by this literature on sovereign-bank funding interactions, we modify the benchmark specification allowing for interactions between the EM sovereign and the EM banks. We allow  $\kappa^e$  to vary according to 6.6, and set the fiscal policy parameter  $\alpha_2$  to be 0.5, allowing for some counter-cyclical fiscal policy.<sup>24</sup>

Figure 13 shows the impulse response of an AE monetary tightening for this case where sovereign funding conditions have a direct effect on private funding conditions. We note that, as before, the net worth of the global bank still declines more when the sovereign borrows in the EM currency. However, different from the previous case, now the contraction in GDP is sharper when the sovereign borrows in foreign currency. This is due to the fact that the government's repayment burden rises much more when debt is denominated in foreign currency (since  $ldgovt = 1$  and  $RER_t$  increases). Consequently,  $\kappa_t^e$  rises much more sharply in this case, leading to a sharper increase in domestic interest rates, decline in credit and hence output.

To summarize, when government debt is risk free, and there is no direct feedback between sovereign and private borrowing conditions, local currency borrowing (original sin redux) can leave the EM even more vulnerable than foreign currency borrowing (original sin), since the financial constrained global banking sector bears greater exchange rate risk in the former case. A more realistic specification with spillovers between the sovereign and private sector funding conditions however makes local currency debt more preferable, but as with the baseline model without sovereign debt, it does not completely eliminate the vulnerability of the EM to changes in AE monetary conditions.

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<sup>22</sup>See appendix 2.2 and Hofmann et al. (2020a) for empirical evidence on the impact of exchange rate shocks on local currency sovereign spreads in EMs that is consistent with our results.

<sup>23</sup>In line with this hypothesis, there is an extensive literature documenting the spillovers between sovereign and private borrowing conditions. For instance Corsetti et al. (2014), Durbin and Ng (2005) and Bedendo and Colla (2015) find that the cost of borrowing in global markets for corporate borrowers tends to be correlated with the yields that their sovereigns pay on their debt. More related to the present model, the literature has also documented extensive evidence on spillovers between sovereign and bank funding conditions (for instance De Bruyckere et al. (2013), Alter and Beyer (2014) and Mendoza and Yue (2012)).

<sup>24</sup>Qualitatively, the results do not change much if we set  $\alpha_2 = 0$  as before.

## 7 Conclusion

On the back of rapid growth in local currency debt markets over the last two decades, EMs have reduced their reliance on external foreign currency borrowing – the so-called “original sin”. However, even when borrowing in local currency, EMs still rely heavily on foreign sources of funding as they have a less developed base of domestic institutional investors. This leaves them vulnerable to capital flow reversals and currency mismatches which are now sitting on the balance sheets of global lenders, giving rise to the phenomenon of “original sin redux” (Carstens and Shin (2019)). This paper presents a model-based evaluation of the original sin redux hypothesis by analyzing the vulnerability of EMs to an advanced economy monetary tightening shock using a two country new Keynesian DSGE model where financial frictions are present in both EM and advanced economy financial systems.

The main takeaways from the analysis can be summarized as follows. First, while borrowing from abroad in local currency reduces the vulnerability of EMs to foreign financial shocks compared to the original sin case, it falls short of eliminating it. Adverse amplification effects of exchange depreciation working through the currency mismatches on advanced economy lenders balance sheets play an important role in this result. However, even if exchange rate amplification effects on borrower or lender balance sheets would be eliminated, e.g. through hedging, adverse spillover effects would persist as financial frictions in advanced economy financial systems give rise to direct reductions of credit supply to EMs when advanced economy financial conditions tighten. Second, additional macro-financial tools can mitigate the challenges from capital flow swings. Foreign exchange intervention appears to be an effective tool to that effect, with the main stabilizing effect of the intervention coming from an easing of the financial constraint of the domestic financial sector through the sterilization operation. Similar effects could therefore be achieved through central bank balance sheet operation in local currency.<sup>25</sup> Capital flow measures also mitigate the effect of external shocks in a manner similar to FX intervention. Third, the development of a larger domestic investor base can reduce the vulnerability of EMs to capital flow swings in the longer run. Finally, local currency external borrowing and a stronger domestic investor base strengthen the transmission of domestic monetary policy in EMs, thus providing more traction to EM central banks in the face of external financial shocks.

The analysis of the paper is based on a tractable two-country general equilibrium framework to highlight the role of financial frictions that give rise to EMs’ vulnerability to financial shocks originating in AEs under different scenarios for financial structure. As such, it leaves open

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<sup>25</sup>See Adrian et al. (2022) for a discussion of the effectiveness and risks associated with the increased use of central bank balance sheet policies in EMs.

several avenues for future research. For instance, the different scenarios considered (currency of denomination of debt and the share of domestic deposits) are fixed exogenously throughout the analysis so that agents are not allowed to adjust the composition of their funding in response to shocks. While this appears to be a restrictive assumption, there is a large body of evidence documenting that sources of funding (for both firms and banks) are fairly sticky, especially at business cycle frequencies considered in this paper.<sup>26</sup> Nevertheless, allowing for endogenous switching between sources of funding would be an interesting extension of our analysis going forward.

Lastly, the focus of the paper is primarily positive, and we abstract from issues relating to optimal policy or optimal coordination of policies across countries (as in [Banerjee et al. \(2016\)](#)). In particular, an extension of the analysis to characterize optimal policy in the presence of multiple policy instruments could be a useful avenue for future research against the background of the ongoing debate about the design of macro-financial stability frameworks in EMs.

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<sup>26</sup>See for instance see for instance [Ivashina et al. \(2015\)](#), [Degryse et al. \(2019\)](#), [Khwaja and Mian \(2008\)](#), [Jiménez et al. \(2012\)](#), [Paravisini \(2008\)](#) and [Paravisini et al. \(2015\)](#).

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# Appendix

## A Microfoundation for the time-varying leverage constraint ( $\kappa$ )

In this section, we provide a simple microfoundation of time varying  $\kappa$  in the paper. Suppose there is a continuum of sovereigns (indexed by  $i$ ) that make up the mass  $n$  that represents the EM country in the main text ( $\int idi = n$ ). All sovereigns are ex-ante identical. Each receives tax revenues  $tax_{i,t}$  from the private economy and borrows from abroad an amount equal to  $B_{i,t}^{Ge}(RER_{i,t})^{ldgovt}$  (fixed amount in local currency term, regardless of the currency denomination of the contract). Each period, a sovereign decides to default on its debt or not. When it defaults, it does not repay its debt, and receives a one-time value of default  $\epsilon_{i,t}$ .  $\epsilon_{i,t}$  can be thought of as the sum of all default costs (political costs, sanctions, preference etc.).<sup>27</sup> We further assume that  $\epsilon_{i,t}$  follows a persistent AR(1) process, such that  $\epsilon_{i,t} = \alpha + \beta\epsilon_{i,t-1} + u_{i,t}$ . The value to the sovereign under the repayment and default scenarios is given by

$$\text{value of repay: } tax_{i,t} - B_{i,t-1}^{Ge}(RER_{i,t})^{ldgovt} \text{ and value of default: } tax_{i,t} - \epsilon_{i,t} \quad (\text{A.1})$$

The sovereign repays the debt if value of repay  $\geq$  value of default.i.e.

$$\text{repay iff } \epsilon_{i,t} \geq R_{i,t-1}B_{i,t-1}^{Ge}(RER_{i,t})^{ldgovt} \quad (\text{A.2})$$

We assume  $\epsilon_{i,t}$  is a shock that has a cumulative distribution function  $G(\epsilon_{i,t})$ . One can think of  $G(\epsilon_{i,t})$  as capturing variations along the political spectrum, and therefore the cost of default across countries. The  $\epsilon_{i,t}$  shock is realized at the same time as other shocks in the model. At each point at time  $t$ , there is a

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<sup>27</sup>See [Arellano et al. \(2017\)](#), [Arellano et al. \(2020b\)](#), [Arellano et al. \(2020a\)](#) and [Dvorkin et al. \(2021\)](#).

cutoff  $\bar{\epsilon}_t$  such that

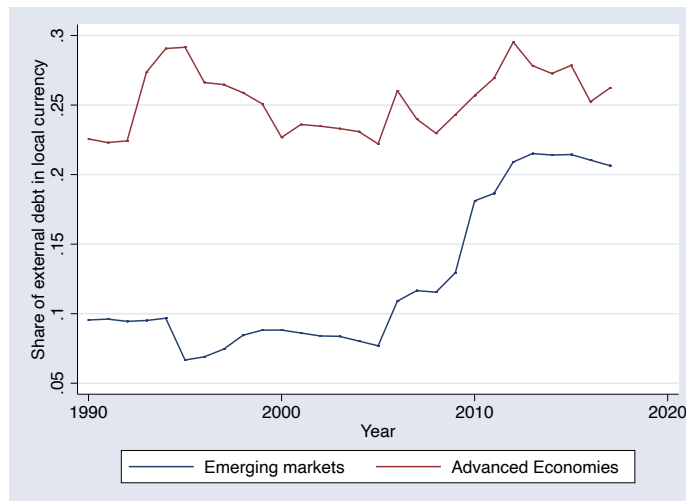
$$R_{i,t-1} B_{i,t-1}^{Ge} (RER_{i,t})^{ldgovt} = \bar{\epsilon}_{i,t} \quad (\text{A.3})$$

A country  $i$  with  $\epsilon_{i,t} > \bar{\epsilon}_t$  chooses to repay, whereas a country with  $\epsilon_{i,t} \leq \bar{\epsilon}_t$  chooses to default. Therefore, a mass  $1 - G(\bar{\epsilon}_t)$  of sovereigns repays their debt each period. Importantly, the size of debt repayment fluctuations move the threshold, according to equation A.3. For example, if  $RER_{i,t}$  is high, it requires a higher threshold  $\hat{\epsilon}_t \geq \bar{\epsilon}_t$  to commit to repay the debt. Under this setting, when the bankers abscond, the assets that lenders can take back becomes  $1 - \kappa - E_t G(\bar{\epsilon}_{t+1}) \equiv 1 - \kappa_t^e$  in the main text. This gives rise to a time varying  $\kappa_t^e$  that depends on the debt repayment of the EM country.

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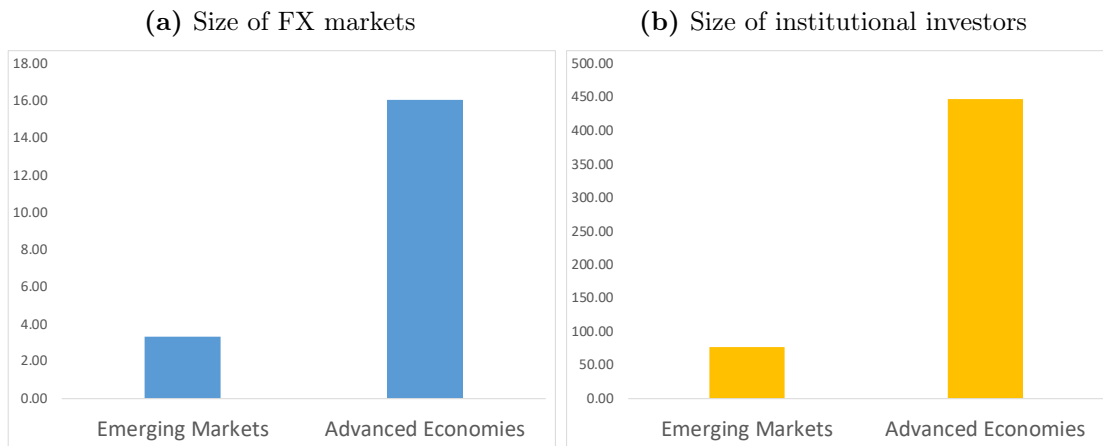
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*Figure 1 – EMs are borrowing more from abroad in local currency*



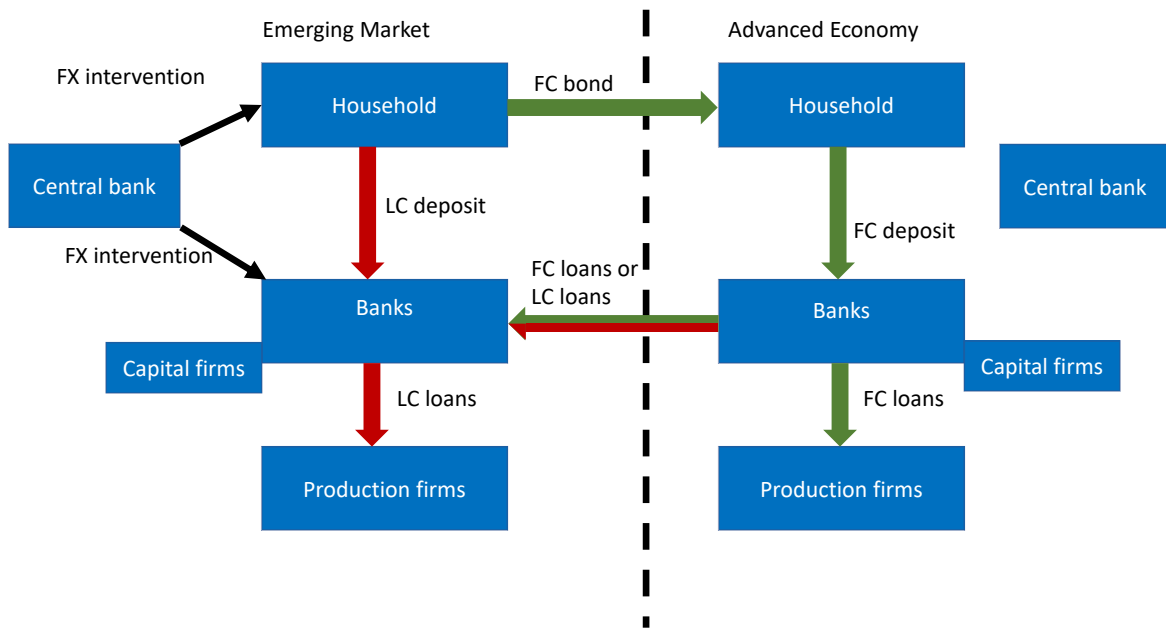
Notes: Share of external debt denominated in local currency. Median across a balanced sample of 14 EMs (CL, IN, KR, MY, CO, PE, CN, AR, HU, ID, BR, PL, PH, MX) and 8 AEs (DK,JP, CA,GB,AU,NO,NZ,CH). Source: [Benetrix et al. \(2019\)](#).

**Figure 2 – EM financial markets are shallower**



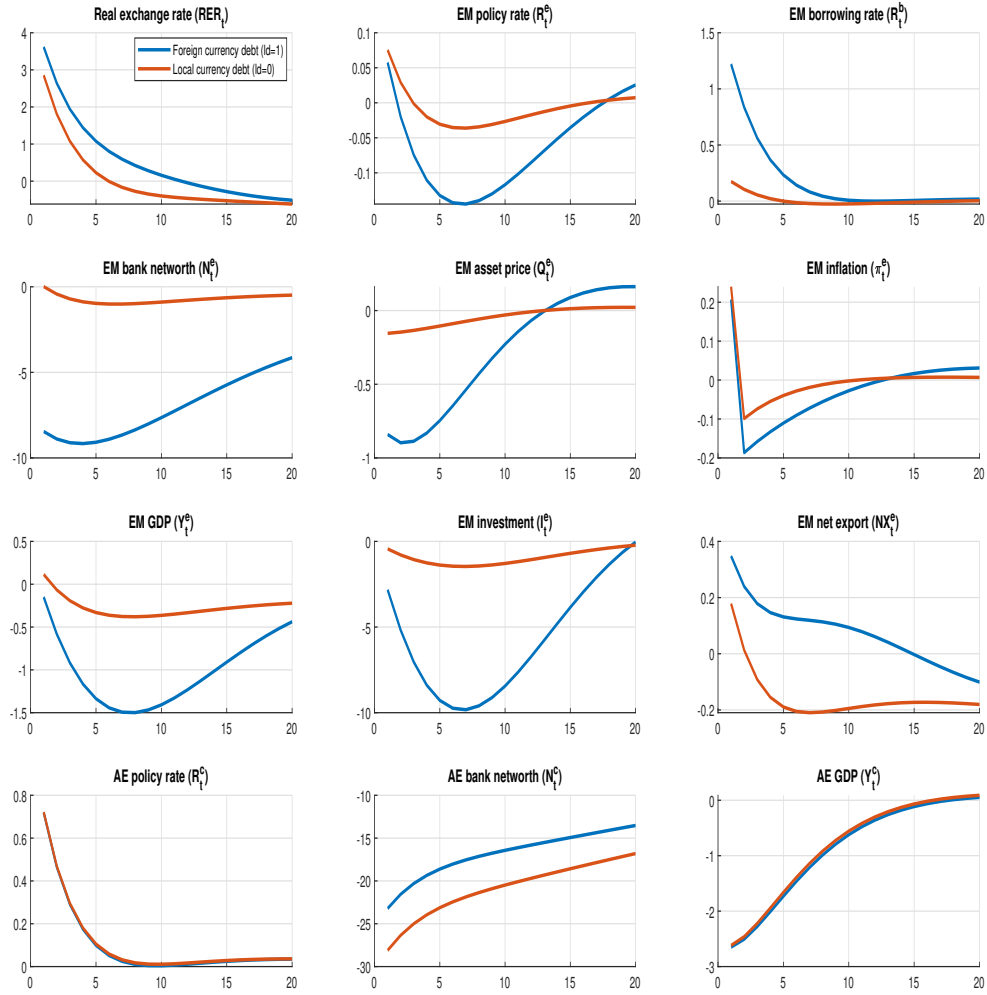
Notes: Panel (a): Average daily turnover in FX derivatives markets as a % of GDP. Medians based on a sample of 16 EM currencies (ZAR, HUF, TRY, CZK, MXN, PLN, KRW, BRL, CLP, RUB, THB, INR, COP, PHP, PEN, IDR) and 6 AE currencies (NZD, AUD, GBP, SEK, NOK, CAD). Source: BIS triennial survey, 2016. Panel (b): Assets of institutional investors as a % of GDP. Sample medians based on 8 EMs (TR, RU, IN, MX, BR, CL, KR, ZA) and 3 AEs (AU, CA, GB). Source: BIS (2019).

*Figure 3 – Schematic representation of the model*



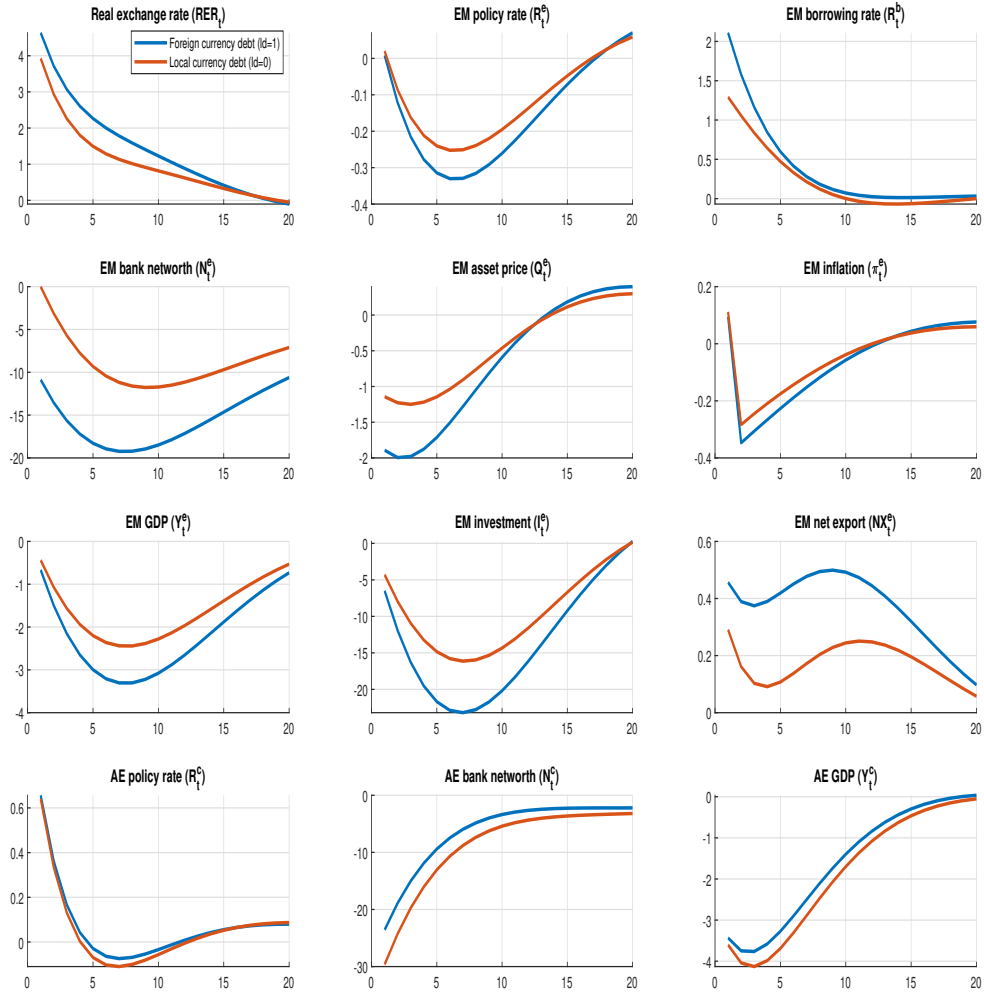
Notes: FC = foreign currency, LC = local currency

*Figure 4 – Advanced economy monetary tightening, absence of lender financial friction*



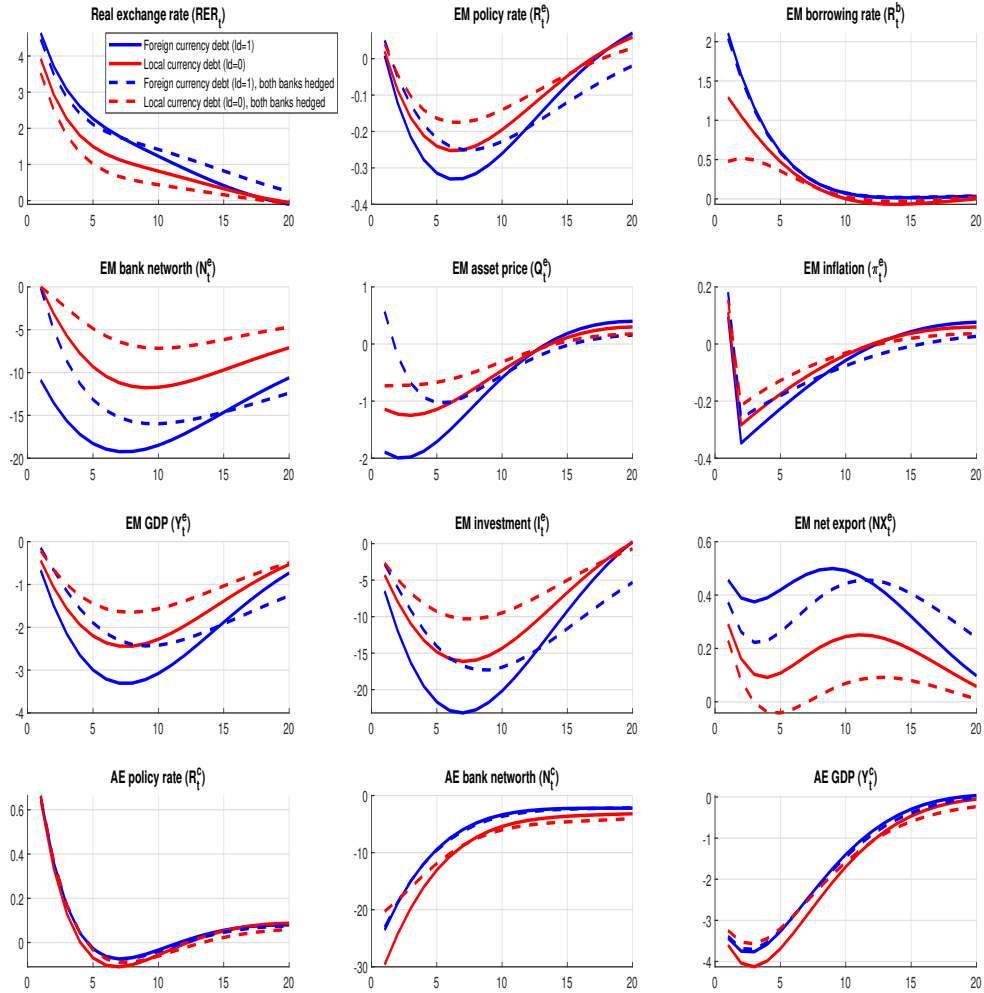
Notes: Impulse response to a 100 basis points increase in the advanced economy risk free rate. Percentage deviations from steady state.

*Figure 5 – Advanced economy monetary tightening, with lender financial friction*



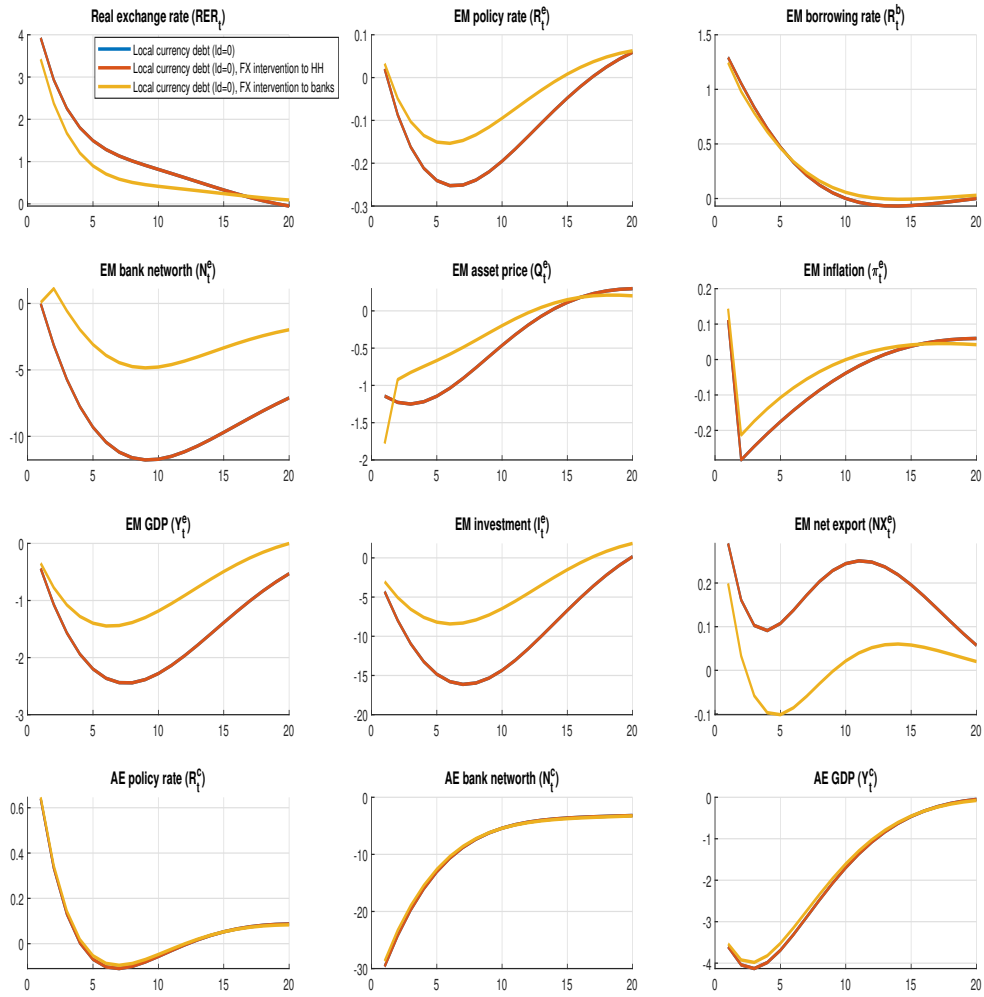
Notes: Impulse response to a 100 basis points increase in the advanced economy risk free rate. Percentage deviations from steady state.

**Figure 6** – Advanced economy monetary tightening: the role of financial exchange rate amplification effects



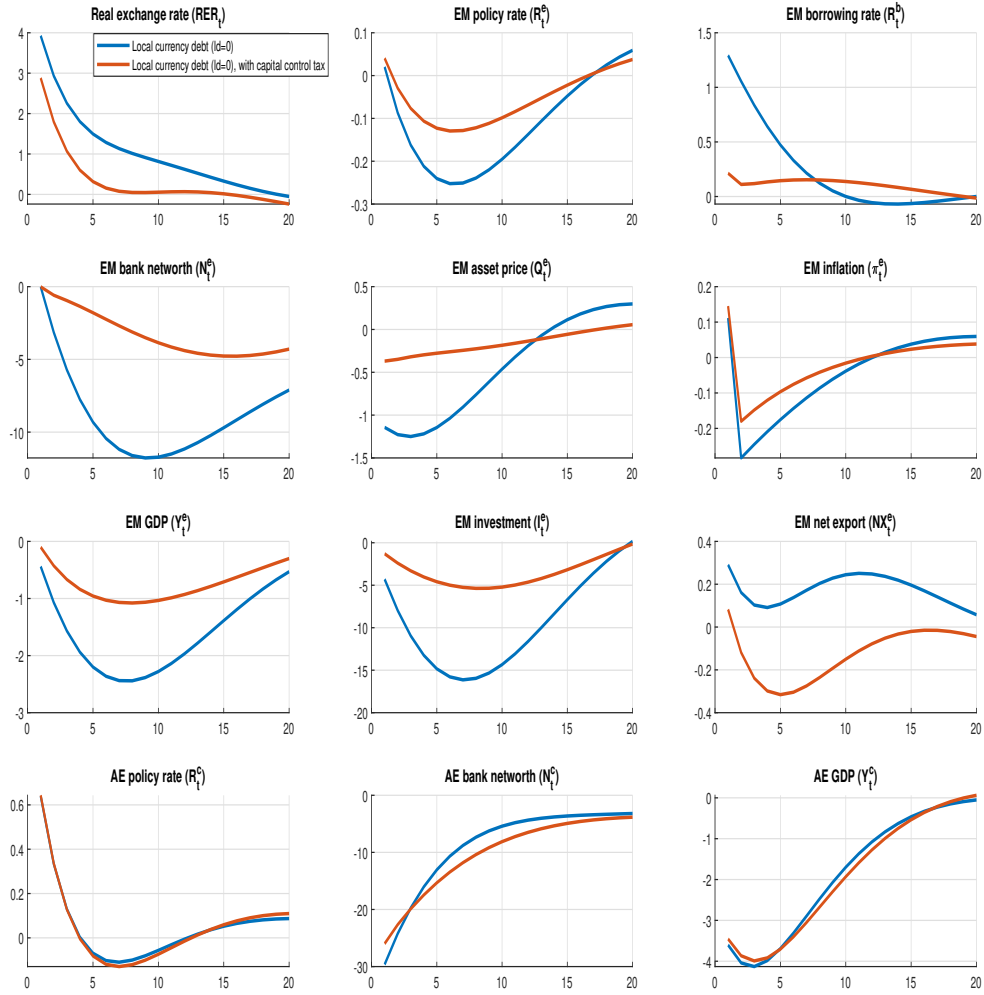
Notes: Impulse response to a 100 basis points increase in the advanced economy risk free rate. Percentage deviations from steady state.

*Figure 7 – Advanced economy monetary tightening: the role of sterilized FX intervention*



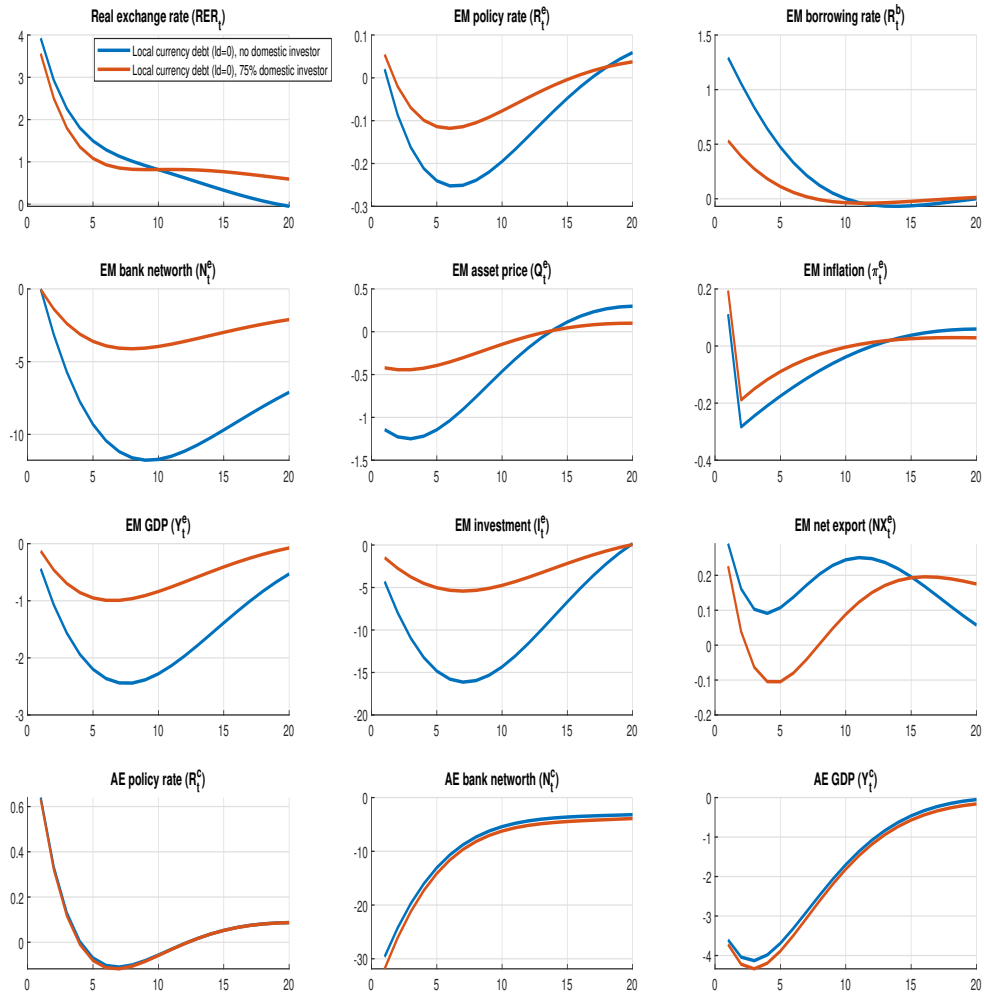
Notes: Impulse response to a 100 basis points increase in the AE risk free rate. Percentage deviations from steady state

Figure 8 – Advanced economy monetary tightening: the role of capital flow tax



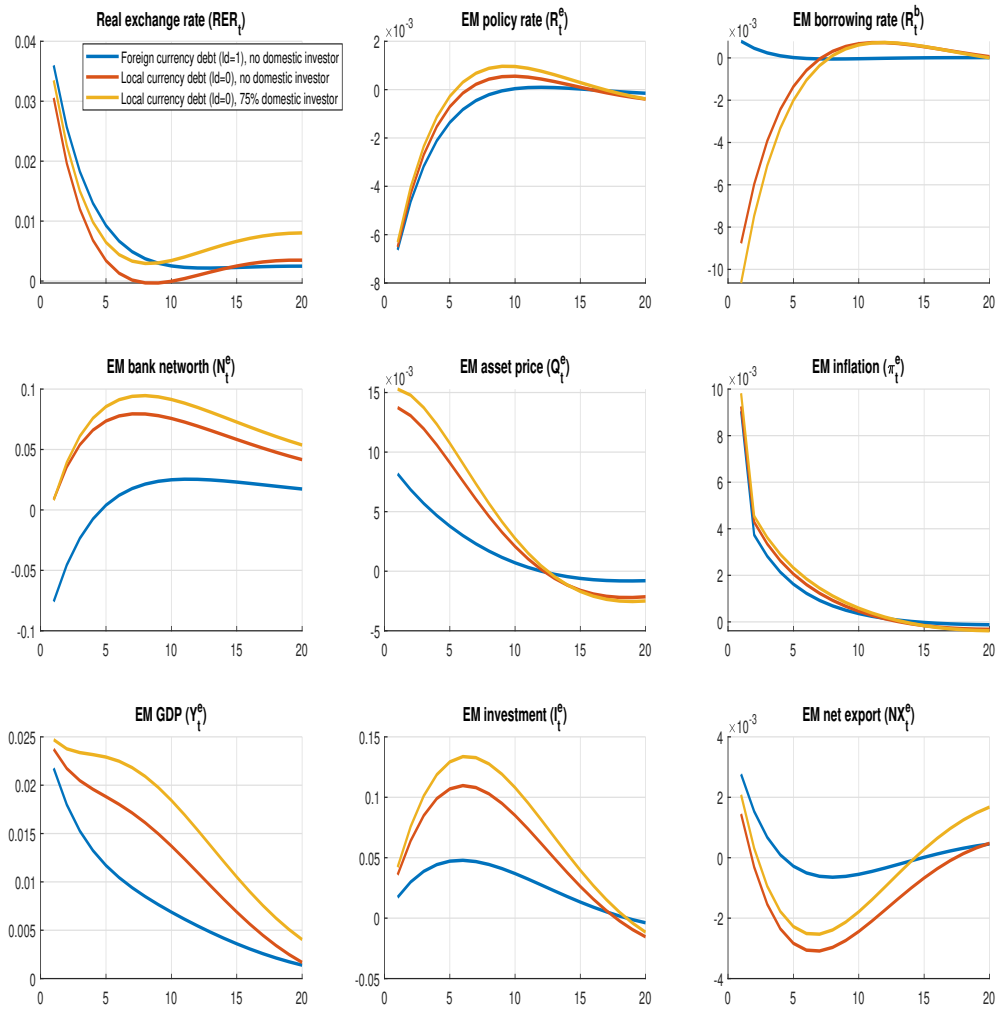
Notes: impulse response to a 100 basis points increase in the advanced economy risk free rate. Percentage deviations from steady state

**Figure 9** – *Advanced economy monetary tightening: the role of the domestic investor base*



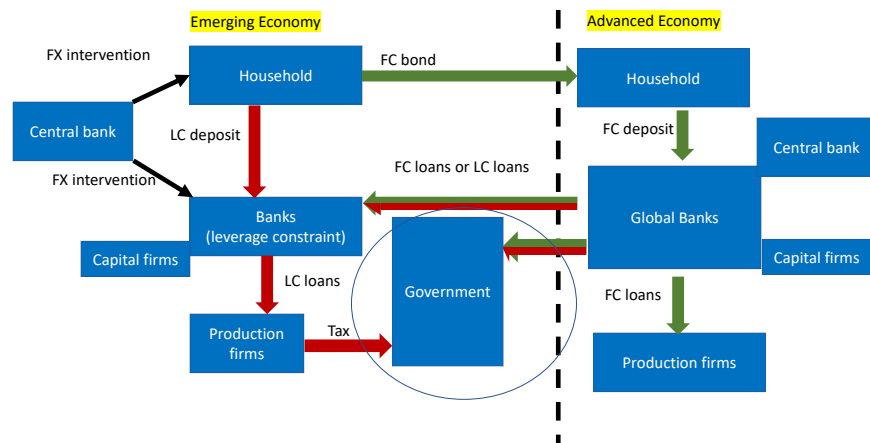
Notes: Impulse response to a 100 basis points increase in the advanced economy risk free rate. Percentage deviations from steady state.

*Figure 10 – Emerging market monetary loosening*



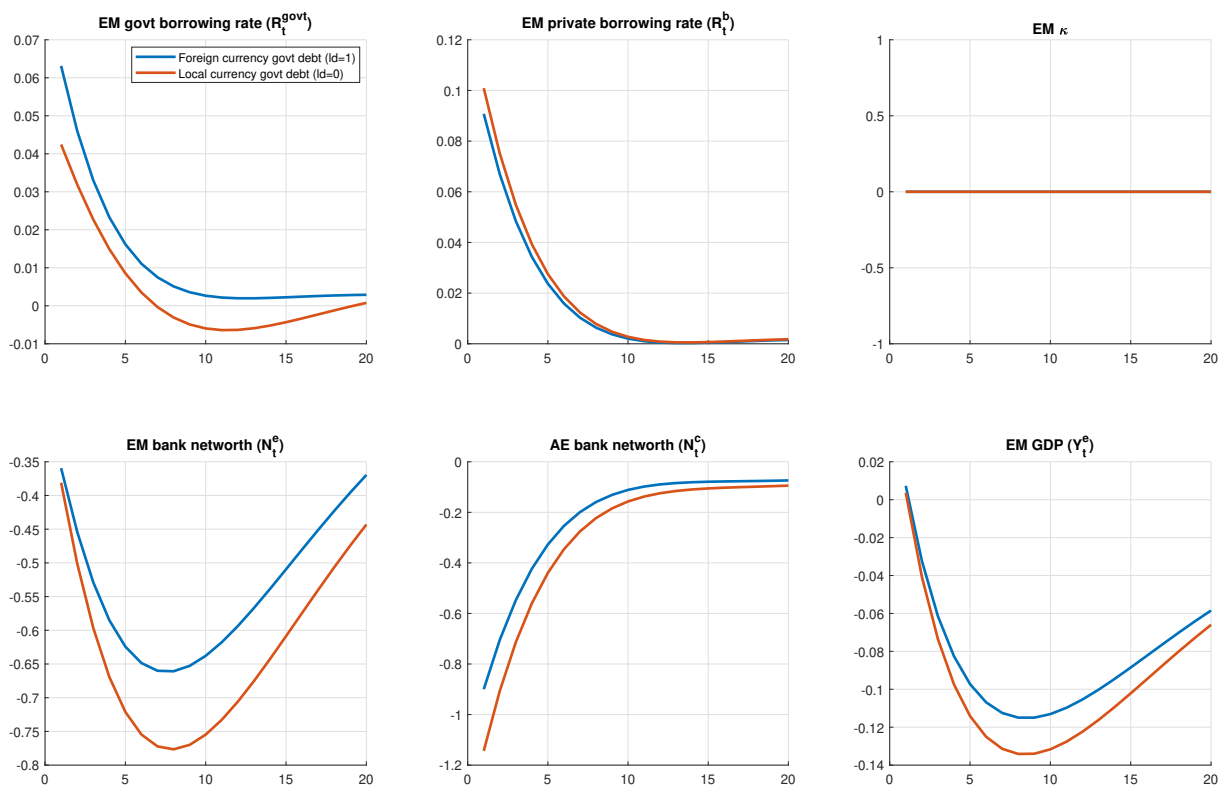
Notes: Impulse response to a 100 basis points decrease in the emerging market risk free rate. Percentage deviations from steady state

*Figure 11 – Schematic representation of the model with sovereign debt*



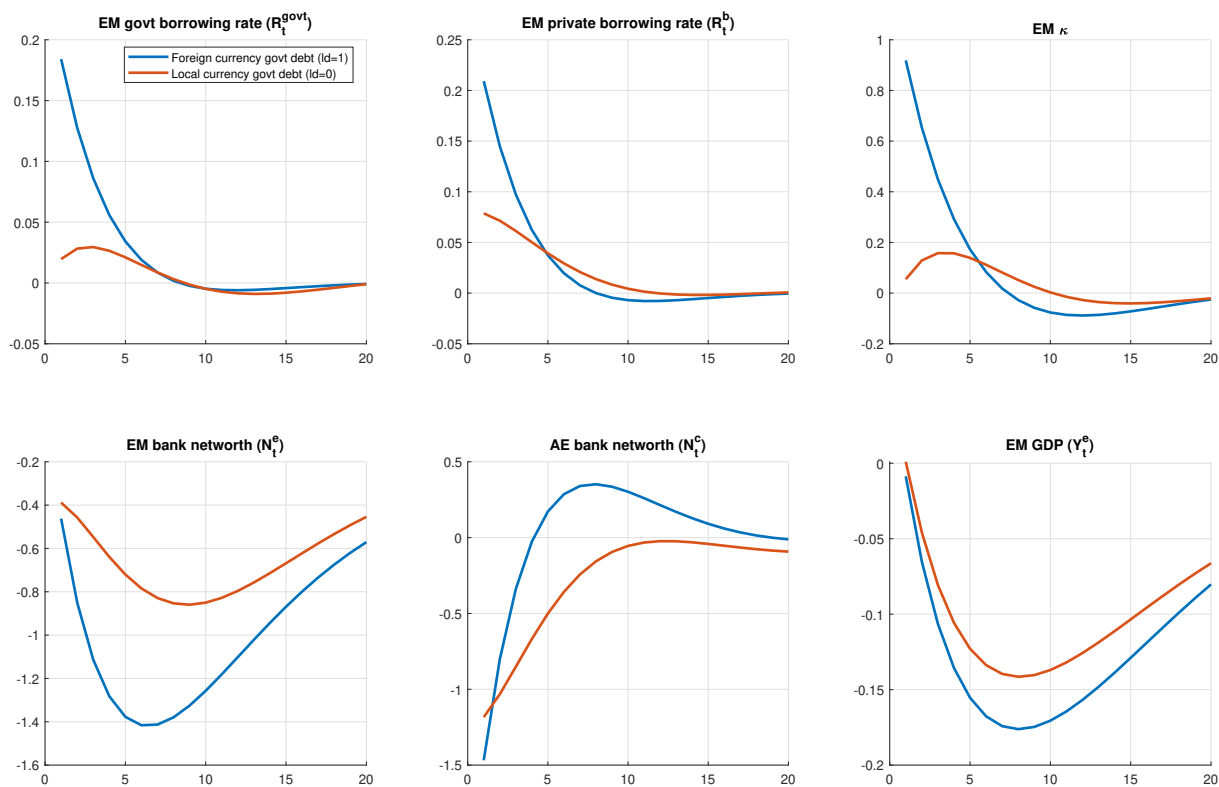
Notes: FC = foreign currency' LC = local currency (from the perspective of the emerging market)

*Figure 12 – Advanced economy monetary tightening in the absence of direct feedback between corporate and sovereign borrowing conditions*



Notes: Impulse responses to a 100 basis points increase in the advanced economy risk free rate. Percentage deviations from steady state. The private sector is assumed to borrow in foreign currency in both cases, only the sovereign debt currency denomination is changing.

*Figure 13 – Advanced economy monetary tightening with feedback from sovereign to private borrowing conditions*



Notes: Impulse response to a 100 basis points increase in the advanced economy risk free rate. Percentage deviations from steady state. The private sector is assumed to borrow in foreign currency in both cases, only the sovereign debt currency denomination is changing.

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**Table 1** – Response of investment to US monetary policy shocks

	(1.1)	(1.2)	(2)	(3)
Sample	EM	AE	EM	EM
$\beta_{osr}$	-0.098*** (0.026)	-0.010 (0.0083)	-0.093*** (0.025)	-0.099*** (0.023)
$\beta_{os}$	-0.28*** (0.079)	0.012 (0.013)	-0.23** (0.082)	-0.18* (0.094)
P value $F(\beta_{os} = \beta_{osr})$	0.02**	0.12	0.08*	0.31
Observations	235	350	235	235
R-squared	0.169	0.412	0.175	0.327
Sample	EM	AE	EM	EM
Country FE	NO	NO	YES	YES
Time FE	NO	NO	NO	YES

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Estimates based on 2.1 for a 100 basis points increase in the US policy rate. For columns 1.1, 2 and 3: Unbalanced panel of 16 EMs (AR, BR, CL, CN, CO, CZ, HU, ID, IN, KR, MX, MY, PE, PH, PL, RU). For column 1.2: sample of 8 AEs (DK, JP, CA, GB, AU, NO, NZ, CH). Source: Benetrix et al. (2019) (annual data from 1990-2007, interpolated linearly to quarterly frequency), IMF International Financial Statistics.

*Table 2 – Impact of foreign monetary contraction on EM GDP*

(1) Trade channel		(2) Financial channel		
(1a) Aggregate demand	(1b) EM depreciation	(2a) Credit Supply	(2b) EM Depreciation	
EM GDP↓	EM GDP↑	EM GDP↓	EM GDP↓	
			(2b1) Original Sin	(2b2) Original Sin Redux
Mechanism				
Import demand↓	Import price↑	Foreign Net worth↓	EM Net worth↓	Foreign Net worth↓
	Import demand↓	Credit Supply↓	Borrowing rate↑	Borrowing rate↑
	export price↓	Borrowing rate↑	Investment↓	Investment↓
	export demand↑	Investment↓		
	CPI inflation↑			

Notes: The table summarizes the different channels through which a foreign monetary contraction affects EM GDP.

*Table 3 – Model calibration*

Variable	Definition	Value
<b>Household</b>		
$\sigma$	Household risk aversion	2
$\nu^e = \nu^c$	Trade openness	0.95
$\beta$	Discount factor	0.99
$\psi$	Inverse of Frisch elasticity	0.276
$\gamma_B$	Portfolio adjustment cost	0.0001
$\varphi_D$	Deposit size*	0 or 4 (=75% of liability)
<b>Trade / goods markets</b>		
$n$	Size of EM	0.2
$\varsigma$	Prob. of price fixed (Calvo pricing)	0.85
$\eta$	Cross-country elasticity	2
$\sigma_p$	Domestic cross-good elasticity	6
<b>Banking sector</b>		
$\theta$	Bank survival rate	0.97
$\delta_T$	Bank capital injection share	0.004
$\kappa^e = \kappa^c$	Divertable fraction*	0.38
<b>Capital producer</b>		
$\varsigma$	Capital adjustment cost	1.728
$\delta$	Capital depreciation	0.025
<b>Monetary authority</b>		
$\lambda_r^e = \lambda_r^c$	Monetary policy persistence	0.85
$\lambda_\pi^e = \lambda_\pi^c$	Taylor coefficient on inflation	2
$\lambda_y^e = \lambda_y^c$	Taylor coefficient on output gap	0.2
$\chi$	Foreign reserve response to exchange rate*	0 or 1

\*Notes: These parameters change across exercises.